Popular Science

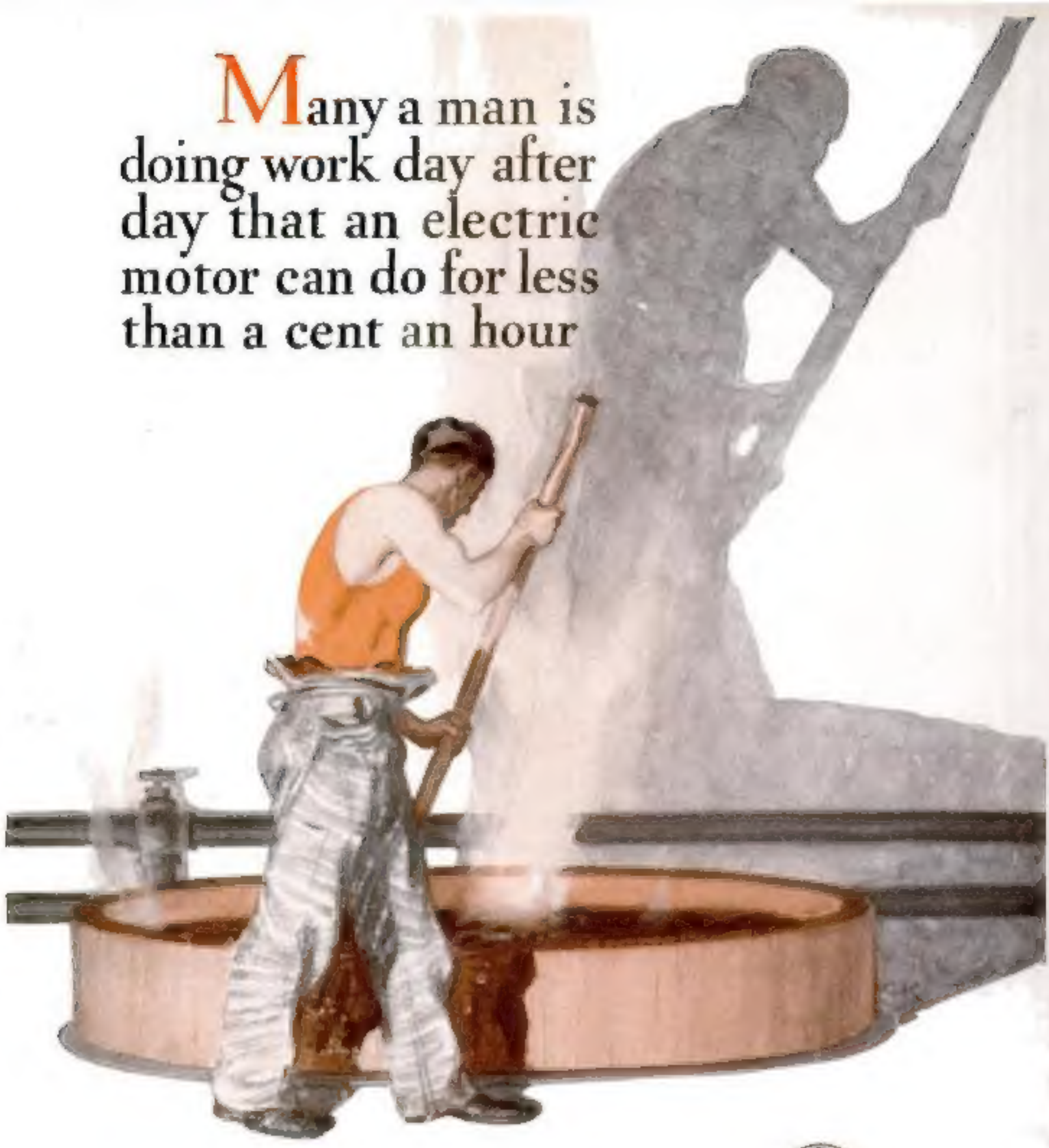
MONTHLY Founded 1872

December
1927
25 cents

How to Build **A Model of the True "Santa Maria"** – *Page 73*

All the New Discoveries and Inventions

Many a man is doing work day after day that an electric motor can do for less than a cent an hour



ASK your electrical expert to help you select the labor-saving electric equipment best suited for your factory, farm, or home.

Guided by human intelligence, electricity can do almost any job a man can do. From stirring to grinding, from lifting to pulling, you will find a G-E motor specially adapted to any task.

GENERAL ELECTRIC

210-35H

FAVORITE—IN SMART CIRCLES EVERYWHERE

Wherever you go, you will find the La Salle the pronounced favorite in the smarter, more discriminating circles. The reason is plain. The more one appreciates charm of contour and of color, and values the finer points of motor car performance, the higher is the LaSalle esteemed. The powerful appeal of the LaSalle lies in the surpassing degree in which it combines unique style and exquisite beauty, with performance so smooth, so brilliant, as to be a continuous source of gratification and delight. Only a car upon which has been lavished the finest workmanship of Fisher Body craftsmen, and which enjoys the engineering supremacy of the 90-degree, V-type, 8-cylinder engine design, could approach so near complete and detailed perfection

You may possess a LaSalle on the liberal term-payment plan of the General Motors Acceptance Corporation—the appraisal value of your used car acceptable as cash

CADILLAC MOTOR CAR COMPANY
DIVISION OF GENERAL MOTORS CORPORATION
DETROIT, MICHIGAN OSHAWA, CANADA

LA SALLE

FROM $2495 to $2685 F.O.B. DETROIT

MANUFACTURED - COMPLETELY - BY - THE - CADILLAC - MOTOR - CAR - COMPANY - WITHIN - ITS - OWN - PLANTS

WHAT IS NEW THIS MONTH

Table of Contents for December

LEADING ARTICLES

FICTION

RADIO

THE HOME WORKSHOP

Astronomy

Automobiles

Aviation

Exceptional People

Explorations

Health and Hygiene

December, 1927, Vol. 111, No. 6. **Popular Science Monthly** is published monthly at 250 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 23, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $3.00; foreign countries, $4.

Laboratory Discoveries

Models

New Devices for the Home

New Processes and Inventions

Photography

Radio

Unusual Facts and Ideas

For the Home Owner

Hints for the Mechanic

Ideas for the Handy Man

Hundreds of Striking Articles in This Single Issue
Cover from Every Angle the Latest Developments
in the World of Invention and Discovery

Here Is a *New Way* to Make Your Money *Earn More*

By WALLACE AMES
Financial Editor

"I SAW some figures today that make me sick," remarked Carl Cutler one evening as he and his wife and two neighbors sat down to an evening of Bridge.

"Yeah?" said Phil Ogden, just mildly interested in further enlightenment.

"They were figures showing gains in securities between 1923 and 1927," continued Carl, who needed little encouragement to go into details. "Do you know, if I had invested $1,000 in American Can at the low price in 1923 I could have sold it for $5,424 in 1927. $1,000 in Pere Marquette would have given me $4,018; $1,000 in General Motors went to $7,980; American Water Works! Wow! $1,000 in that stock would have netted me $22,500! Why shouldn't such figures make me sick?"

"Now I'll tell one," interrupted Phil. "In 1923 I invested in American Agricultural Chemical at 36; recently I saw that stock quoted at 233. I got into American Woolen at 87 and out at 24. I thought Central Leather was a buy at 32, it has since dipped below 10. Middle States Oil nicked me for a row of good iron men when I bought at 11 and sold at 2½. Figures sometimes make me sick, too."

"So you're the guy who bought those stocks," laughed Carl Cutler.

"IT'S fine for you to be talking now. Anyone can tell what is going to happen after it is all over. Those stocks had plenty of friends when I bought them." Phil had a good defense.

"Furthermore, if you had bought any of those rich babies," said Phil as a further rejoinder, "you wouldn't have held them. You would have grabbed 10 or 15 points profit and today you would be just as sick to think of the real big profit you let slip away.

"In spite of the losses I took and the profits you didn't make I am still of the opinion that there must be some way for 'little fellows' like you and me to invest shrewdly with our $100 or $1,000 or our occasional $5,000 and I think I have found the way." As Phil was all warmed up to go into details and Carl an interested listener, the bridge game broke up, the wives began to talk of their next shopping trip and the men to discuss investments.

"The greatest truth I got out of that little investigation that I am telling you about," Phil went on, "is the value and importance of diversification. Suppose, as an extreme instance, in addition to the stocks on which I lost money, I had bought those you mentioned that have gone way up. I would have made money even after swallowing my losses.

"The investments of insurance companies and savings banks are safe for two reasons. They buy good securities in the first place. In the second place they invest in so many different securities that a loss in one is not serious."

"Yes," Carl chimed in, "but insurance companies and banks have millions to invest to your and my hundreds."

"THIS plan I have been looking into takes care of that, too," Phil assured him. "It is called an investment trust. It gives you the practical advantages of a million-dollar investment fund and you can invest small amounts such as $100 or $1,000 or $5,000.

"As it was explained to me, the investment trust sells us its own stock or bonds. By selling to a lot of people it raises maybe two or three million of capital. It uses this capital to make investments all over the world, wherever conditions are good. It invests in many kinds of industry, gets extreme diversification.

"The trust has all sorts of records and information to go by and experts to study them and decide what is best to do. In 1923 a well-managed investment trust probably would have invested pretty heavily in stocks as prices were low and bound to go up sooner or later. In 1927 the same trust would have sold most of its stock at a profit and invest the money in bonds.

"An investment trust makes most of its money from stock dividends and bond interest. But it also makes money buying low and selling high. Holding such a large number of securities it is entirely probable to own some which offer substantial market profits."

"DO YOU mean to tell me," Carl broke in, somewhat excitedly, "that investment trusts make the fabulous profits shown in those figures that gave me such a pain?"

"I doubt it," Phil answered. "In fact I don't believe anybody gets such profits. One isn't likely to be lucky enough to buy at the very bottom, hold on and sell at the very top the stocks that make the biggest advances.

"Furthermore, a well-managed investment trust is a sane, conservative business. If one of its investments advances materially and the trust managers believe the top has been reached, they would probably sell and take their profit. They would sell out a security in which they had no market profit if they thought to hold it would likely result in loss.

"After a trust sells a security to take a profit, it may go still higher. After they sell to avoid a loss the impending trouble may be averted after all. But on the average the trust's trained judgment as to when to buy and when to sell is probably sound.

"You and I, by owning stock or bonds in an investment trust get our share of the success of its operations in the shape of extreme safety plus interest or liberal dividends."

"That all may be true," said Carl, "But I do not intend to have anyone controlling my investments. I'll pick and choose what I like and buy or sell when *I* think best."

"Isn't it a fact, Carl, that you really buy or sell on somebody's say so? You invest in this or get out of that because someone in whom you have confidence tells you it is the thing to do."

"Well, I guess that's so," Carl agreed, beginning to come around to Phil's way of thinking.

"Furthermore," Phil added, "a good investment trust not only has expert management, but the By-laws specifically state just what can or cannot be purchased. Get a copy of the By-laws before you make your investment and if you are not satisfied with their provisions there are plenty of other trusts for you to choose from.

"These propositions I am talking about are *investment* trusts. They are not speculative schemes. None of them will tell you that they bought Ford stock when Henry was starting to make flivvers. Probably not one of them would tell you that they made 1,000% or 2,000% in American Water Works. But I know of one that made 60 points in Allied Chemical. It went higher after that, but the trust had a nice profit and conservative judgment said take it.

"In fact, there was no American investment trust when Ford was looking for money. The first one is only a few years old. The idea originated in Scotland and England fifty or sixty years ago but the plan was not introduced over here until recently. Those old British trusts that have built up their surplus, investing and re-investing, always conservatively, but none the less shrewdly, now pay 20%, 25% and

Make Your Money Earn More

(Continued from page 4)

sometimes as high as 30% on their original stock. And they are thought so well of that their stock often sells in the London market on a 5% basis or even less."

"So it's a Scotch idea," said Carl. "Well, it must be good. Can you give me the name and address of the investment trust you have been looking into?"

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

How to Build an Independent Income (1927 Edition)—Describes a plan for buying 6½% First Mortgage Bonds by payments of $10 or more a month, and shows the results that may be accomplished by systematic investment. Address: The F. H. Smith Company, Smith Building, Washington, D. C. Ask for Booklet 75.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

Behind the Scenes where Bonds Are Made tells how you can retire in fifteen years and have an income equal to your present living budget. This booklet can be secured by writing to Cochran and McCluer Company, 46 North Dearborn Street, Chicago, Ill.

Thirty-two page illustrated booklet, describing one of the largest public utility companies, of interest to investors. Utility Securities Company, 230 S. LaSalle St., Chicago, Ill.

The Common-Sense Test of Investment Trusts suggests an easy method by which you may correctly judge the worth of any investment trust before putting your money into it. United States Fiscal Corporation, 50 Broadway, New York, will send a free copy if you request Circular CS.

JUST OUT—

New List of

Radio Products

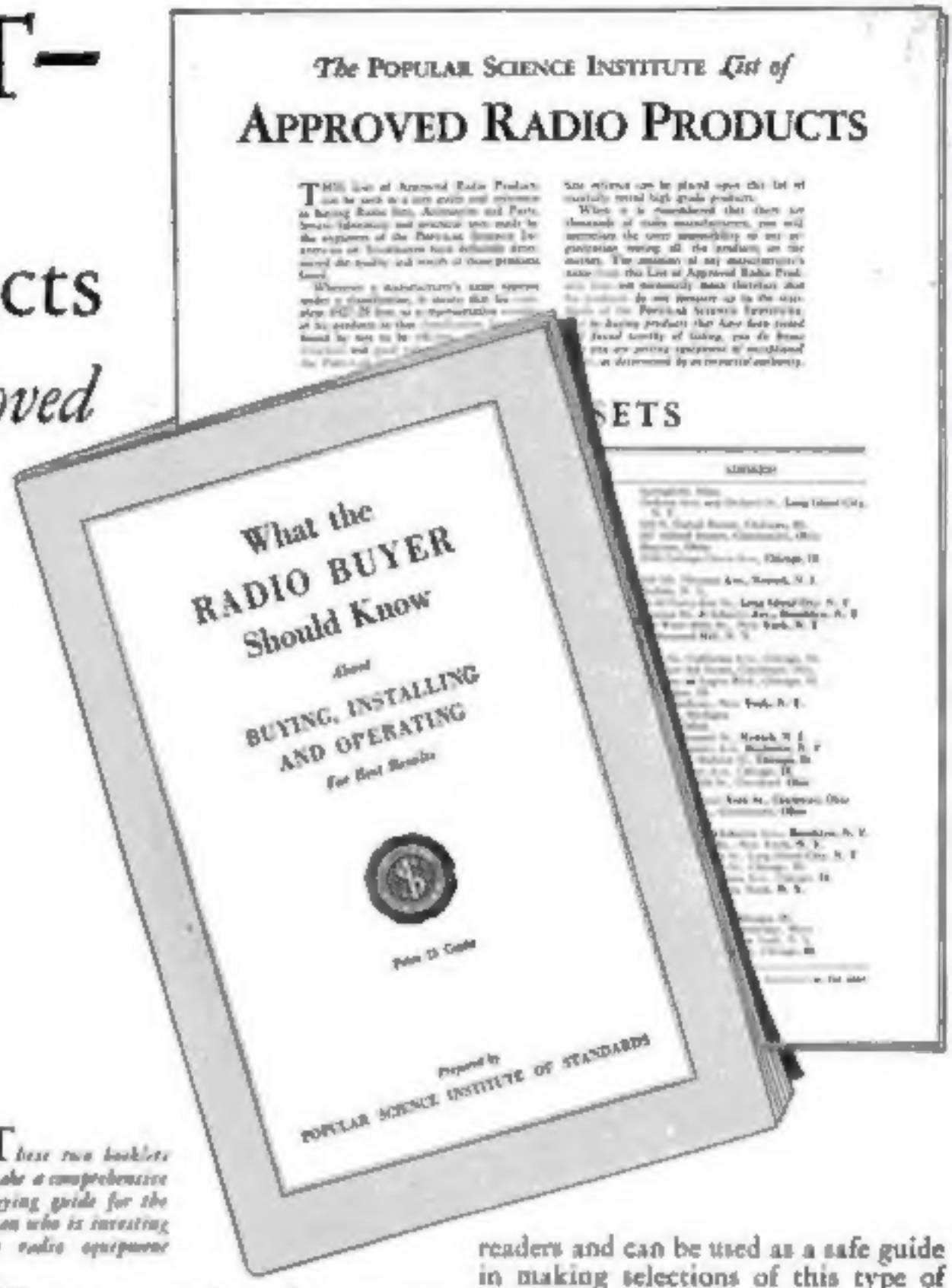
Tested and Approved

JUST as new models of automobiles are brought out annually at one season, there is now a definite time of the year when practically all new radio products for the year are put on the market. This is logically in the fall when radio interest is at its height—the long winter evenings ahead, extra fine radio features, together with the Christmas gift problem, being largely responsible.

While the Popular Science Institute of Standards issues at intervals during the year up-to-date bulletins listing radio products approved as the result of tests, it finds that a *completely revised* list is necessary in the fall.

Toward the end of July, manufacturers start sending in to the laboratories of the Popular Science Institute early production models of their new 1927–28 equipment. Then begins the very busiest season of the year for The Institute's radio engineers.

Tests are made in relays, one test on one type of product being run at a time. For instance, in the case of radio receiving sets, a group of receivers are put through the selectivity test at one time. Next, each of the sets are subjected, one by one, to the test that accurately determines their rating in so far as tone quality is concerned. And, so on, with the other tests essential for judging the general merits of a radio receiver. The results of the different tests on the various sets are carefully noted, in each case.



These two booklets make a comprehensive buying guide for the man who is investing in radio equipment

No final determination of worth is reached, however, until all the tests on all the sets have been made. Then the new 1927–28 standards for radio receiving sets are established and the test notes regarding the various receivers are checked against these. It is then that a decision is reached as to which of the radio sets are to receive endorsement and approval.

The same thing applies to other types of radio equipment. In the case of many products, such as socket power devices, vacuum tubes and other apparatus containing parts of limited life, a very long period of time must elapse before the final determination of worth is made. This is due to the "life tests" that are necessary.

The publication of the new Approved List of Radio Products in the fall represents, therefore, the results of weeks of testing and the establishment of new standards, and is of definite news value. This bulletin is available at no charge to all Popular Science readers and can be used as a safe guide in making selections of this type of equipment.

Another publication that the Popular Science Institute of Standards has put out this year represents a further aid to the man who is buying a radio outfit and wants to get the most from his investment. This is a 20-page booklet entitled "What the Radio Buyer Should Know." Besides telling you what you can expect in the way of radio reception, how much you must pay, how the cost can be cut down and other pointers on buying, it also contains full instructions on installation and nine pages are devoted to hints on operation—such as tuning for selectivity and tone, eliminating noises and other points that the radio owner should know. There is a charge for this booklet of twenty-five cents.

In publishing this and the List of Approved Radio Products, the Popular Science Institute feels that it has covered the buying problem as carefully and thoroughly as can be done. To secure these, address the Popular Science Institute, 250 Fourth Ave., New York City.

Whatever type of radio power equipment you want—

WITH BATTERIES OR WITHOUT

Balkite "A" *Contains no battery.* The same as Balkite "AB," but for the "A" circuit only. Enables owners of Balkite "B" to make a complete light socket installation at very low cost. Price $35.00.

Balkite "B" *One of the longest lived devices in radio.* The accepted tried and proved light socket "B" power supply. The first Balkite "B," after 5 years, is still rendering satisfactory service. Over 300,000 in use. Three models: "B"-W, 67-90 volts, $22.50; "B"-135, *135 volts, $35.00; "B"-180, 180 volts, $42.50. Balkite now costs no more than the ordinary "B" eliminator.

Balkite Chargers

Standard for "A" batteries. Noiseless. Can be used during reception. Prices drastically reduced. Model "J,"* runs 2.5 and .5 amperes, for both rapid and trickle charging, $17.50. Model "N"* Trickle Charger, runs .5 and .8 amperes, $9.50. Model "K" Trickle Charger, $7.50.

** Special models for 25-40 cycles at slightly higher prices.*

Prices are higher West of the Rockies and in Canada.

for whatever type of radio set you own— whatever you want to pay for it—

Balkite *has it*

First noiseless battery charging. Then successful light socket "B" power. Then trickle charging. And today, most important of all, Balkite "AB," a complete unit containing no battery in any form, supplying both "A" and "B" power directly from the light socket, and operating only while the set is in use. The great improvements in radio power have been made by Balkite.

This pioneering has been important. Yet alone it would never have made Balkite one of the best known names in radio. Balkite is today the established leader because of Balkite performance in the hands of its owners.

Because with 2,000,000 units in the field Balkite has a record of long life and freedom from trouble seldom equalled in any industry.

Because the first Balkite "B," purchased 5 years ago, is still in use and will be for years to come.

Because to your radio dealer Balkite is a synonym for quality.

Because the electrolytic rectification developed and used by Balkite is so reliable that today it is standard on the signal systems of most American as well as European and Oriental railroads. It is this principle, used in all Balkite Radio Power Units, that does away with the necessity of using tubes for rectifying current—that makes Balkite permanent equipment with nothing to wear out or replace.

Balkite has pioneered—but not at the expense of the public.

Today, whatever type of set you own, whatever type of power equipment you want, whatever you want to pay for it, Balkite has it. Production is so enormous that prices are astonishingly low.

Your dealer will recommend the Balkite equipment you need for your set.

Balkite "AB" *Contains no battery.* A complete unit, replacing both "A" and "B" batteries and supplying radio current directly from the light socket. Contains no battery in any form. Operates only while the set is in use. Two models: "AB" 6-135, *135 volts "B" current, $44.50 "AB" 6-180, 180 volts, $74.50.

FANSTEEL PRODUCTS COMPANY, INC., NORTH CHICAGO, ILLINOIS

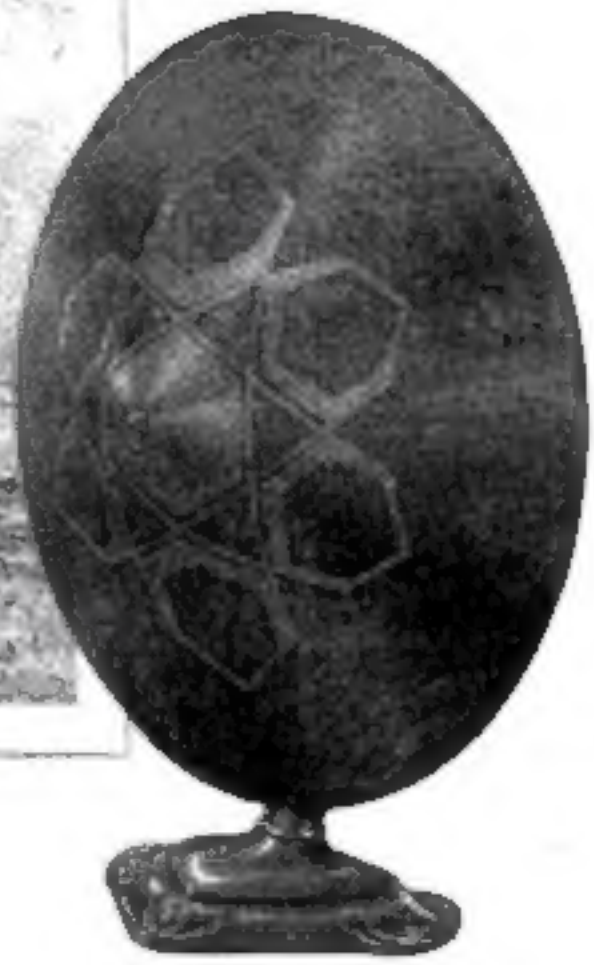
Licensees for Germany: Siemens & Halske, A. G. Wernerwerk M Siemensstadt, Berlin

Sole Licensees in the United Kingdom: Messrs. Radio Accessories Ltd., 9-13 Hythe Rd. Willesden, London, N. W. 10

FANSTEEL

Balkite *Radio Power Units*

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.



When the Gauls transmitted important news, it was shouted from tower to tower through a megaphone. Within fifteen hours the news of the Roman massacre at Orleans was thus sent to Auvergne 120 miles away.

Natural Tone—Perfection in radio reception is naturalness of tone. It must reach you as it left the studio—clear and life-like. It must be rich, deep, resonant—admitting no trace of "radio accent".

Nothing is so fatal to tone quality as an "unsympathetic" loud speaker. Reception suffers unless set and speaker work in perfect harmony.

Grebe has built a *Natural Speaker*. With it your set will reproduce tone more clearly and faithfully, affording you purer tone quality.

But in combination with the Grebe Synchrophase Seven, it attains its highest capabilities.

The Grebe Natural Speaker is priced at $35; the Grebe Synchrophase Seven at $135. Send for Booklet P; then ask a Grebe dealer to demonstrate both of these Grebe masterpieces in combination.

GREBE SYNCHROPHASE RADIO ®

A. H. Grebe & Company, Inc., 109 West 57th Street, New York City

Factory: Richmond Hill, N. Y. *Western Branch:* 443 South San Pedro Street, Los Angeles, California

Makers of quality radio since 1909

® This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Popular Science MONTHLY

DECEMBER, 1927 SUMNER N. BLOSSOM *Editor* VOL. III, NO. 6

Rubber from Weeds

My New Goal—EDISON

The Great Inventor Tells How Today, at Eighty, He Is Solving the Hardest Problem of His Life

By FRANK PARKER STOCKBRIDGE

I HAVE just been privileged to watch the man who has changed the world in the act of starting another revolution.

Thomas A. Edison, at eighty, is beginning a new line of research. It—"the most complicated problem I have ever tackled," he told me—is the objective of this investigation, begun at a time of life when most men have long since retired, when few are still able to work at all.

Nine hours a day in his laboratory, three or four or five hours every evening in his library, engrossed as deeply as he ever was in the problems of the multiplex telegraph, the electric light, the telephone, the phonograph, the motion picture or the alkaline storage battery.

For more than fifty years the question "What is Edison working on now?" has been important to the whole world, for he has been producing one revolution after another, in the habits, the thoughts, the business customs, even the manners of the world.

Mentally listing the Wizard's achievements—the microphone and the tasimeter, those marvelous instruments which detect, respectively, sounds previously unheard and minute temperature changes not before suspected; the mimeograph, which revolutionized business methods, and its offspring, waxed paper, which revolutionized food distribution and the culinary habits of a nation; the grinding machines which have made Portland cement better and cheaper; the system of power distribution which has altered all industrial methods; the electric railway and the stock ticker, the megaphone and a dozen other minor devices of everyday use—listing these with the other and more widely known creations of Edison's brain and contemplating the changes which have come over the world in this half-century which history may call the "Age of Edison," it seemed to me that some highly important and interesting questions remain to be answered.

How does Edison determine what to invent? Having determined that, how does he go about it? What is the secret which has enabled one man to turn the world upside down in his own lifetime?

I went to West Orange, New Jersey, to the vine-covered brick laboratory at Llewellyn Park which has been the Wizard's workshop for forty-five years, to see if I could find the answer. I found it.

The Wizard who seeks to grow rubber in America and refine it by machinery seeks in what he calls "the only way" ceaseless study and experimentation in the laboratory twelve hours and more a day

EDISON told me what he is doing, how he is doing it, how he came to undertake it. And in the telling he disclosed his secret—the secret of how great inventions are made!

It began as every important invention starts—with the determination of an economic need for it. Ben Franklin stated it concisely: "Necessity is the mother of invention." When Brush showed his arc light at the Centennial of 1876, young Edison saw the economic need of an electric light which could be divided into smaller units, and out of that need sprang the incandescent lamp.

"The United States never has and never will have on hand enough rubber to run the country for more than a year," Edison told me. "Henry Ford, Harvey Firestone and I were considering what this country would do in case of a war which cut off our rubber supply. Don't make any mistake about that war; it will come. We may run along for a

good many years without it, but sooner or later the nations of Europe will combine against the United States. The first thing they will do will be to cut off our rubber supply.

"WE CAN'T fight a war without rubber. All our transportation is on a rubber tire basis. To move goods to and from railroads and steamships we must have rubber. There are not enough horses and mules to haul the commerce of peace time, let alone war. Except on the farms, the supply of horses is diminishing all the time.

"So we decided that the thing for us to do was to find a source of rubber, for war emergency purposes, so that we can produce it quickly right here at home. And that is what I am working on now."

"You are not interested in rubber as a commercial product, then?" I asked.

"Not at all," replied Mr. Edison. "Please get that right. What Ford, Firestone and I are doing is—well, I call it a 'stunt'—something in which there is no possible profit for us. We can't compete commercially with the tropics in the production of rubber."

Edison and his friends, Ford and Firestone, have been experimenting for several years on their Southern Florida lands with the cultivation of the standard varieties of rubber trees and plants, and with numerous sub-standard kinds. For forty years Mr. Edison has been developing at his winter home at Fort Myers, Florida, the most complete garden in existence of tropical and subtropical vegetation; on Mr. Ford's 18,000 acres at La Belle, near by, rubber trees of every known sort have been growing for ten years and more. And—"we can't compete with the tropics in commercial rubber," says Edison.

"The home of rubber is in the tropics," he went on. "The wages on the plantations are thirty cents a day. The commercial production of rubber from the trees which constitute the principal source of it, requires an immense amount of labor. American workmen can't and should not be asked to work for the low wages necessary to make commercial rubber cultivation possible.

"SO COMMERCIAL rubber in the United States in competition with tropical rubber is out of it, except for a limited amount of guayule rubber being produced in California by the Inter-Continental Rubber Company. They ship several thousand pounds a week of rubber extracted from the guayule shrub. It is a recognized product, quoted on the Rubber Exchange. They started in Mexico, where the guayule grows wild, but they had some trouble there with government interference and moved to California.

"But all the guayule rubber grown in the United States will not provide a large enough supply in case of war. We use nearly four hundred thousand tons of rubber a year, and it all comes from the tropics, except what I have just spoken of. In time of peace that is all right. Some of the rubber plantations are owned by American capital, and more will be. So long as we can run our ships without interference we can get all the rubber we want at a fair price."

Rubber for war—that is the economic need which has spurred Edison to his latest inventive effort. But the objective must be specifically defined. In the case of the electric light—which offers the closest parallel among his inventions to his present rubber problem in the manner of its development—the terms of the objective were based upon the existing standards of lighting, furnished by gas. The new light must compete commercially with gas in cost of production and delivery to the consumer. The lamp itself must cost so little, require so little attention and last so long as not to be a noticeable charge.

So in taking up the rubber research, Edison, Ford and Firestone worked out the definite objective to be pursued by Mr. Edison, by comparison of what he was to seek with existing standards.

Rubber drying on tall poles on a plantation outside Singapore in the Federated Malay States

"What we must find is something which will give an adequate supply of rubber at a price of around two dollars a pound," Mr. Edison told me.

"That would be a high price in peace time, but not in time of war. There would not even be an end to joy-riding with rubber at two dollars. We paid as high as a dollar and a quarter only two or three years ago, and nobody stopped buying tires.

"To get rubber at two dollars means doing everything by machinery. The rubber tree has to be tapped and a small amount of latex collected by hand each day. That alone would eliminate the rubber tree, even if climatic reasons did not."

"Those considerations don't eliminate the guayule, though," I suggested, for guayule rubber is produced almost entirely by chemical or mechanical labor-saving processes.

INSTEAD of yielding a sap, or latex, like the rubber trees of the tropical plantations, the guayule shrub, not much more than a foot high and producing more than ten percent of its weight in dry rubber, contains the gum in all of its cells except the wood of the trunk. The bark and roots contain the most. The shrubs are uprooted, washed, and ground, and the rubber is then either dissolved out by a secret chemical method—the process used in the Akron rubber factories to which the dry shrubs are shipped—or by the mechanical agglomeration of the rubber particles—the process used in California to produce pure rubber for shipment.

Mechanization of the whole process has made it possible for guayule rubber to [illegible] rubber [illegible] [illegible] California, Arizona, New Mexico and Texas will [illegible] But Mr. Edison rejected [illegible] suggestion.

"Not enough for us. But it has too long [illegible] be sure. We have had [illegible] trouble [illegible] prompt [illegible] [illegible] conditions. And we must wait our war [illegible] before starting [illegible] plantations. It takes [illegible] shrub to grow large

Rubber on the Edison farm at Fort Myers, Fla., the most comprehensive tropical and sub-tropical garden extant, where the Wizard grows every rubber plant and possible rubber plant obtainable

enough to yield rubber enough to make it worth while

"We must find something which will produce enough rubber, within a year after the beginning of war, to replace the year's supply which we normally have on hand, something which won't be occupying valuable land meantime or tying up capital or requiring a continuous expenditure of money without any return."

"Something like a wheat crop?" I asked.

"EXACTLY," Mr Edison answered. "An annual crop, something which the farmer can sow in the field, by machinery, which will come to maturity in eight or nine months, which can then be harvested by machinery and from which rubber can be obtained by processes almost entirely mechanical, with the least amount of hand labor. It must be something which will stand light frosts, for there is no part of the United States where there are not occasional frosts. Probably it will be grown in the South but not necessarily. And the farmer ought to make a dollar a pound profit to encourage him to grow it."

There I had it, the clearly defined picture of the specific objective of the inventor's quest. No hit-or-miss affair this. "But what are the steps whereby the inventor actually invents?" I asked him.

"I don't like to talk much about rubber until I know more about it," he demurred, with a smile. "I have hardly got started yet. The first thing is to find out everything everybody else knows and begin where they leave off. So I started by reading every book, pamphlet and document of every kind that I could lay my hands on, that had anything to do with rubber. It is a very large subject." He waved his hand toward a big table near his desk, piled high with huge volumes and tiny pamphlets. Many were the famous Edison note-books, of which there are thousands, bound, classified and indexed. They contain the minute records of his great inventions, step by step. With one of his staff, Barnish Jones, who reads a dozen languages, he had just spent five days in the library of the New York Botanical Gardens, digesting hundreds of volumes on rubber in Spanish, Portuguese, German, French and other languages.

ONE day last Summer, an associate told me, Mr. Edison learned of a new book on rubber just published in Germany. No copies had reached America.

"Send a man to Germany by the next ship to bring me a copy of it," he instructed his secretary. A cabled order served, however, but not until he reads this, if he does, will Mr. Edison know that the precious volume was not personally conducted from Bremen.

"I am still going through the books," Mr. Edison went on. "I am trying to get the whole subject so thoroughly into my head that I can view every phase of the problem in the light of thorough knowledge. That is the only way to study a subject, to read all the literature on it at one time."

Therein the inventor disclosed another secret of his genius. Because his biographies describe him as a train newsboy with only three months of formal schooling, there has grown up an Edison myth of a poor boy, uneducated and entirely self-taught. As a matter of fact, Edison's parents were well-to-do and his home education from his mother, formerly a successful teacher, was probably the most intensive and comprehensive ever acquired by a boy of his time. Having digested before the age of twelve such tomes as Gibbon's "Rome" and Hume's "History of England," every book on science which was obtainable and all but the mathematics of Newton's "Principia," he became a railroad "newsie" because it enabled him to read the latest publications, gave him five hours every day to study in the Detroit public library, and provided money for the precious chemicals with which he performed every experiment described in the books. The true picture of young Edison, the "tramp telegrapher" shows him spending every dollar of his wages above the poorest kind of living, for books and chemicals, reading lines of print as rapidly as others read words, always a student always the intelligent, scientific experimenter. Nothing he has ever done was accidental; everything has been founded upon thorough scientific study and thoroughly scientific experiment.

"I know of no man in history with such a thorough grounding in science as Edison has," one of his old associates told me.

First the theoretical knowledge, then the experiments. Mr. Edison was not ready to talk about the experiments. To my question whether he had found any plants which seemed to come anywhere near meeting the requirements which he had described, his reply was evasive. "We have only just begun," he said, and I had to go to other sources to learn about the experiments his explorers are bringing from every part of the world outside of the tropics.

Tapping a rubber tree in British Guiana. Only a little of the sap, or latex, flows and the trees must be re-tapped and tended daily by thousands of rat-tai

The weed from which Edison may make rubber. This leafless desert milkweed has been found in the inventor's laboratories to contain 5 percent of rubber. When the tops are cut off new shoots sprout

JUST as he did when seeking a fiber to make a filament in the incandescent electric light, Mr. Edison has sent and is still sending out expeditions to find every plant which yields anything like a rubber gum, and bring to the laboratory a sufficient quantity for experiment. Only last September he sent another young man to South America.

One "caravan" left a few weeks earlier for a year's tour of the desert regions of the Southwestern United States; others are scouring Europe, Asia and Africa. Already hundreds of specimens have been received and experts under Mr Edison's immediate personal direction are testing them for rubber content and trying to devise ways for its economical extraction.

More than 250 different species of plants, many that can be sowed and reaped in the same year, have already been listed in the Edison laboratories as containing measurable amounts of rubber. Some already hold out promise of becoming, through breeding and selection, the thing for which Edison Ford and Firestone are looking.

The most promising are of the milkweed family.

SO THE big job Edison at eighty has tackled is already well under way. There is still an immense amount of work to be done, for not only must the right plants be found and methods of sowing, cultivating and harvesting be developed by experiment, but the efficient and economical method of extracting the rubber on a large scale by machinery is yet to be devised. And Edison, working twelve to fourteen hours a day at the job, promises to keep at it, "at least until I have found all there is to know about rubber."

Air-Rail Lines May Span U.S.

Great Steam Roads and Government Weigh Plans to Reduce Transcontinental Time by Forty Hours

By WILLIAM P. MacCRACKEN, Jr.

"A TICKET for San Francisco please."

"Do you want to go by a.r, air-rail or rail?"

That question will be asked of passengers applying at ticket offices in all our large cities unless something unforeseen develops to dampen the interest of railroad executives in the practicability of coördinating passenger service by air with passenger service by rail. There are many interesting possibilities for combined air-rail trips.

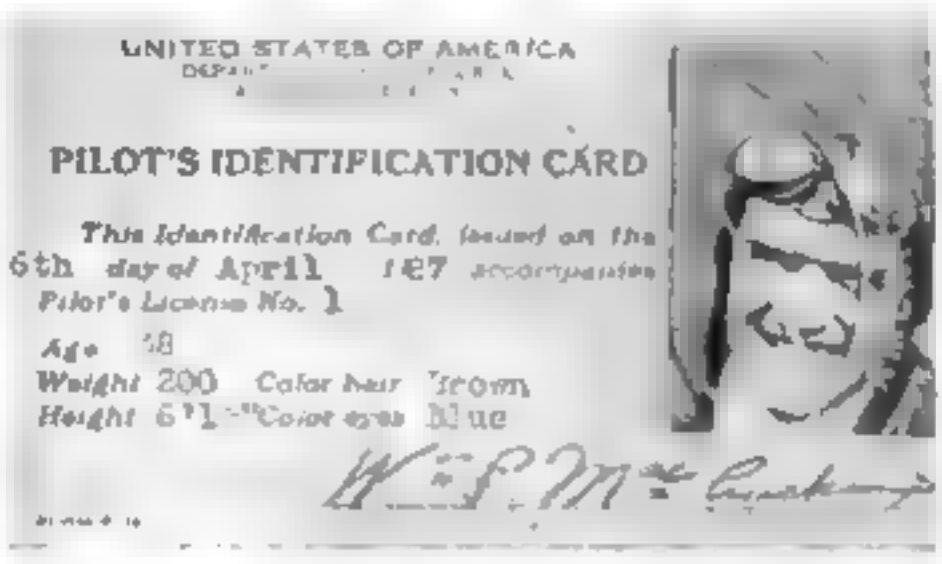
Leaving New York at 2:45 p.m., Eastern Time, on Sunday, we will say, a traveler will arrive in Chicago at 9:45 Central Time, Monday morning after bath, shave and breakfast on his all Pullman train. He will be whisked to Chicago's new lake front municipal flying field and take off for Cheyenne, Wyo., at 10:30 o'clock. His plane will land him in Cheyenne at 6:50, Mountain Time, that evening slightly more than thirty hours from the Atlantic seaboard. An all-rail trip, by existing schedules, would have consumed fifty-two hours of travel.

The traveler will leave Cheyenne by rail at 7:40 p.m., reaching Ogden, Utah, at 9:20 Mountain Time, next morning. A swift flight from Ogden, starting at 9:40 a.m., Pacific time, Tuesday, will place him in San Francisco at 4:30 p.m. in time for dinner—a little more than two full days after his departure from Manhattan Island.

Reduced to the language of a time-table the trip will appear like this:

	BY TRAIN	
Lv. New York	2:45 p.m. (Eastern Time)	Sunday
Ar. Chicago	9:45 a.m. Central Time	Monday
	BY AIRPLANE	
Lv Chicago	10:30 a.m. (Central Time)	Monday
Ar Cheyenne	6:50 p.m. Mountain Time	Monday
	BY TRAIN	
Lv Cheyenne	7:40 p.m. Mountain Time	Monday
Ar Ogden	9:20 a.m. Mountain Time	Tuesday
	BY AIRPLANE	
Lv Ogden	9:27 a.m. Pacific Time	Tuesday
Ar San Francisco	4:30 p.m. Pacific Time	Tuesday

FANTASTIC as it may seem, this schedule is based on existing time cards of transcontinental railway service, with flying time adjusted to fit the train connections. The flying time is based on present daily performance of the air mail. It is not unreasonable to assume that the development of patronage for the combined service will bring readjustment of train schedules to effect even greater saving of time. The saving effected by this time card is approximately forty hours. The fastest scheduled connections over the same route, by extra fare trains, would occupy ninety-one hours and forty minutes, from 5:30 Sunday afternoon to 9:10 Thursday morning. The air-rail combination consumes fifty-two hours and forty-five minutes.



Pilot of Commercial Aeronautics

THE first airplane pilot's license issued by the U. S. Department of Commerce went to Mr. MacCracken, Assistant Secretary for Aeronautics of the Department, author of this article. What he has to say is important because it indicates definite steps toward the air-rail transportation which was foreshadowed in the September POPULAR SCIENCE MONTHLY

NO STRAIN of the imagination is required to picture this journey as one of the everyday prospects of the early future. The matter has been taken up with the railroads by the Department of Commerce, and is under consideration as one of the possibilities in transportation development.

The plan has many points which entitle it to favorable attention.

One point is that the railways have a ready-made machinery for handling passenger traffic—ticket offices, baggage facilities, advertising departments and soliciting forces. The railroads are the normal channels of transport. The assumption is natural that air transportation would flow along the same channels. The railroads could provide fine service in this new form of travel and would prevent the fares from going into outside hands, thus offsetting whatever loss of passenger mileage their trains might suffer.

Their ticketing facilities would draw traffic that might not be attracted by isolated lines operating independently. The passenger who could make all arrangements at a New York ticket office would be more likely to patronize the coördinated air-rail service rather than change repeatedly to independent routings.

Still another factor of importance is that the greater flow of traffic attracted by the combined service would permit elasticity of facilities, enabling the roads to maintain flying equipment to meet abnormal travel demands. When a single airplane has been booked to its full capacity of eight passengers, it will be simple enough to take bookings for as many as may be required. If additional planes are not in the local "yards," they can be brought from other fields on short notice.

For the business man, whose time is figured in dollars, the possibilities of the service are too important to be overlooked. There are scores of main travel routes on which the time-saving would be of material significance. The banker could leave Chicago at 8 a.m., fly to Ponca City, Oklahoma, by 4:15 p.m., take train at 8:40, and sleep until he reached Fort Worth or Dallas for breakfast. If he should be bound for Galveston, and cared to spend three hours longer in the air during his first day's journey, his plane would land him in Fort Worth at 7:25 p.m., permitting him to take a night train and reach Galveston at 9:35 the next morning—less than twenty-six hours from Chicago. The rail journey takes approximately forty-eight hours.

SUPPOSE our business man wants to make a quick trip from St. Louis to Boston. Instead of taking the fast nine-o'clock train Monday morning, he could spend a large part of the day in his office, hop off from St. Louis at 1:30 p.m., Central Time, and make the five-hour flight to Cleveland in time to catch a train at 6:15 and be in Boston at 10:35 the next morning—saving half a business day in St. Louis and almost two hours in Boston.

Another striking illustration is afforded by the journey from Minneapolis and St. Paul to Fort Worth and Dallas. By rail the distance is approximately 1,100 miles. Fast through train service requires two nights and a day, or around thirty-nine hours.

By combined air-rail service a business man would leave Minneapolis at 11 o'clock Monday morning and fly to Wichita, Kansas—600 miles—by five o'clock in the afternoon. At Wichita he could overtake and board the identical train which left Minneapolis at 4:30 Sunday afternoon, have a comfortable dinner in the dining car, sleep in a restful Pullman, and be in Fort Worth or Dallas for early breakfast. His time-saving would be the eighteen hours that elapsed between train time at 4:30 Sunday afternoon and airplane departure from Minneapolis at 11 o'clock Monday morning.

Between New Orleans and Chicago the extra fare trains consume twenty-one hours. Instead of leaving New Orleans at 12:30 noon on such a train, the busy business man could remain at his desk till after the close of banking hours, hop off by plane at 9:30 o'clock and overtake his train at Memphis for arrival at Chicago at 9:30 the next morning.

Not only in air-rail service, but in independent routing does the airplane hold possibilities as a saver of time. A case in point is afforded by the trip from Washington to Norfolk. Because of geographical layout, and the intervention of the Chesapeake Bay, the rail routes involve a trip broken at Richmond and occupying 6¼ hours. The rail distance is about 210 miles. By airline reckoning the distance is but 145 miles, which means that an airplane passenger can make it in approximately an hour and a half.

TOURIST traffic, one of the important sources of income in passenger transportation, is the major possibility of air-rail lines.

Consider the case of the Grand Canyon, in Arizona. Under present conditions of all rail service, the tourist is carried in a through sleeping car from Chicago to Los Angeles by way of the Grand Canyon. His car is cut out of the through train at Williams, Arizona, makes the sixty-four-mile trip to the Grand Canyon, and is picked up at Williams twenty-four hours later by the through train of the following day. There is a loss of twenty-four hours in reaching Los Angeles.

By air-rail combination the through passenger could leave a train at Winslow, Arizona, at 11:30 a.m., Mountain Time, leave Winslow by airplane at noon, fly over the Grand Canyon region with a leisurely stop for afternoon tea and resume his place in the same train at Needles, Calif., at 7:25 p.m., Pacific Time. By this method he would see more of the majestic scenery than he could see from an all-surface trip, and he would lose no time in his arrival at Los Angeles.

THE tourist who has not traveled by air does not know what he has missed in the enjoyment of sight-seeing. Not only does he see the general panorama, but he sees the details as well—the farmer with his plow, the crawling motor vehicles on the highway, the homes of the inhabitants, and the full cross-section of life in the country he traverses. In passing over Kansas City, for example, he sees the magnificent suburban homes and their surrounding estates in a comprehensive view that would not be possible to the surface traveler.

The idea of air touring is to have each plane accompanied by a guide. Typical service is illustrated by a trip from New Brunswick, New Jersey, to Boston.

Each passenger receives a strip map of the course, of the same general type as the maps used by motor tourists. The map shows the distance to be covered and locates towns by route markers and beacons so that the passenger always knows where he is.

The plane swings over northeastern New Jersey and southeastern New York State, while the guide points out interesting features of the shifting panorama—Newark, Staten Island, New York harbor, the Statue of Liberty, the Hudson and East Rivers, Manhattan Island and Brooklyn, Hell Gate, Long Island and the Sound. Passing over Connecticut he directs attention to the handsome estates around Stamford, the factories at Norwalk, Bridgeport and Meriden, the capitol at Hartford, and so to Boston and the State House on Beacon Hill.

Luncheon will be served from the space available at the forward part of the "car."

Cities throughout the United States are alert to the value of airports for attracting tourist travel.

The Federal Government stands sponsor for air travel by virtue of the Congressional act creating the Aeronautics Branch of the Department of Commerce. Under this act the Department is charged with the encouragement and regulation of the use of aircraft in commerce.

THE duties of the Aeronautics Branch include such work as establishing and maintaining civil airways, corresponding to surface highways, and the operation and maintenance of intermediate landing fields, lights, signal and radio direction-finding apparatus similar to aids furnished to water navigation. Other functions include the charting of airways and the publication of "road maps of the air," encouragement of local airports, and study of possibilities for development of air commerce, trade and industry.

The News Pictorial

Measuring to Billionth of Inch

A device to measure objects to a billionth of an inch is the product of P. P. Croft, Bell Telephone Laboratories expert. Measurements are determined by effects on a photo-electric cell

New Radio Photos

Governor Smith of New York (right) is seen examining a new radio device that will, if perfected, receive a photographic print from a photo-broadcasting station and record it on a roll of sensitive photographic paper by means of an electric light. The device is experimental and would not now be of value in a radio set because there are no stations that broadcast pictures. The Governor's photo was sent us a test

United States Deliberately Burns an Airplane

Far from being a tragedy of aviation, this remarkable scene is the prevention of one. It is an antiquated and unsafe air mail plane being destroyed at Maywood, Ill., by Federal orders to guard against its falling into the hands of "wildcat" pilots, who might try to use it with tragic results. Private owners are strongly urged to take similar precautions

been rebuilt better than ever. The scene is at the Azuma Bridge which was a veritable sea of flames immediately after the quake

Myths about Mars Exploded

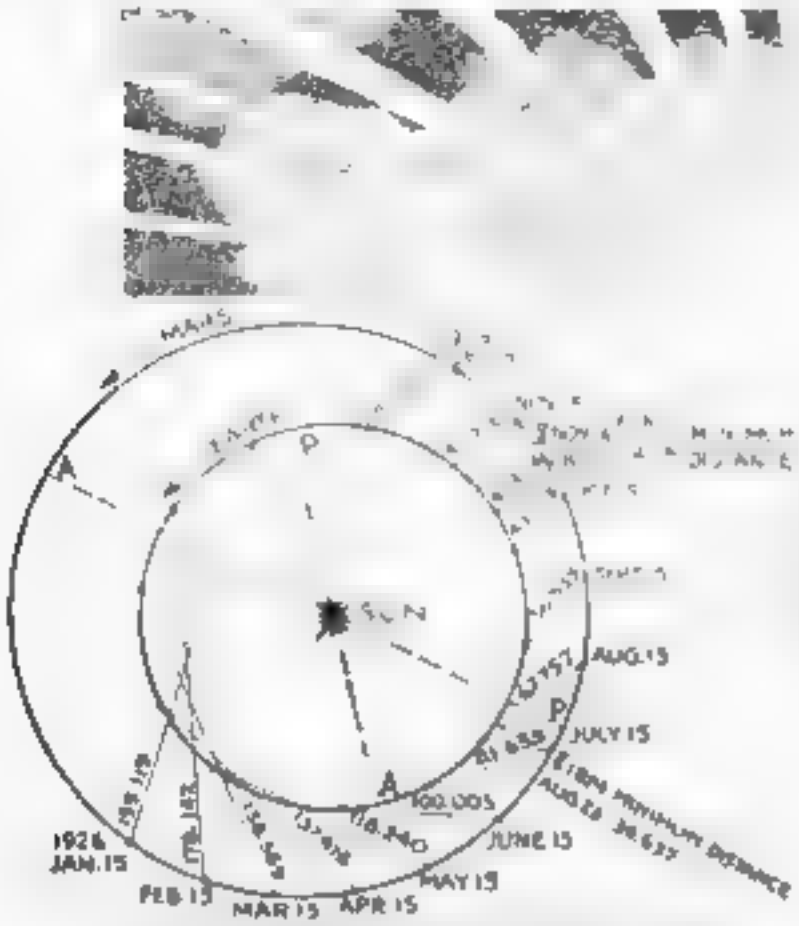
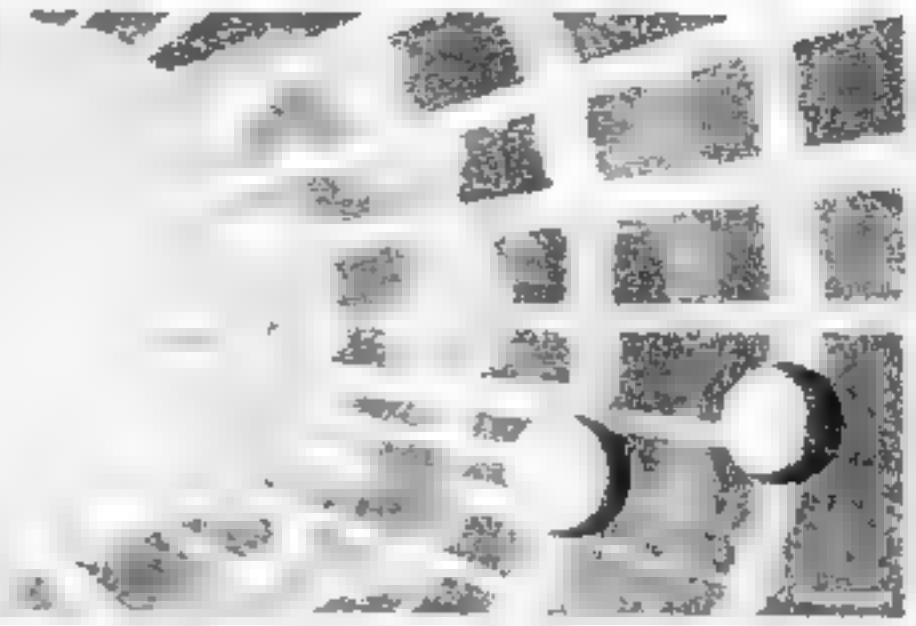


Diagram showing distances in millions of miles between Mars and earth in 1926 as they traveled around the sun, and least known distance in 1924. A means aphelion, point farthest from the sun; P, perihelion



Planet No Home of Supermen, Says Astronomer, but Bleak Red Desert World, Arid and Freezing, Where Only the Hardiest Plants Can Live

By DONALD H. MENZEL.

Lick Observatory, Mount Hamilton, Calif.

IN RECENT months astronomers putting to new far-seeing spectacles of science have gained the first truly authentic introduction to that most fascinating neighbor of ours in the solar community—the planet Mars. Studying the ruddy face of the mysterious traveler as he swings in his far-off path about the sun they have observed features far different from those long painted by popular guess and fancy.

No traces of weird giants wandering over strange desert lands have they found, no mighty race of supermen, digging mammoth canals and living in a realm of mechanical wonders undreamed of on earth. Instead, they have discovered substantial facts supplanting century-old speculation—facts about the atmosphere of Mars, its climate, landscapes and probable life, from which they hope eventually to form a close acquaintance.

In short, they have revealed a new Mars—a world of frigid nights and warmer days, of high-sailing clouds and parched sun where only the hardiest of plants may grow; a place strikingly similar to the earth, yet so different that earth men, transplanted there, would pant vainly for breath through thirsty throats.

This new picture of the red planet has come about largely through the development of great telescopes, the magic of color photography, the perfection of delicate measuring instruments and the application of human logic in the interpretation of remarkable photographs taken during the closest recent visit of the planet, about a year ago.

Since Mars never comes nearer to us than 33,000,000 miles, the wonder is that men have been able to read its features at all. It is as if some friend of yours, standing on a mountain top ten miles away, were to open this magazine and ask you to read it. Even through the world's largest telescope the sentences would appear only as blurred lines, and the illustrations mere blotches. So the face of Mars, viewed through that telescope, appears streaked with lines and patches.

THE task of reading Mars, however, is complicated by the earth's atmosphere. Air currents rising from the ground often distort the image as if it were viewed across a hot stove.

Any study of Mars, then, requires two distinct operations; first, observation of the crude, blurred picture; second, the interpretation of what this picture represents.

Come with me to the Lick Observatory and have a look at Mars through one of our great telescopes. Even your untrained eyes will quickly observe that the brilliant red disk is covered with a delicate tracery of markings. There is a white spot, like a pearl button, on one edge. Next you discover a few vague green-gray shadows and, if your sight is keen, the network of linelike shading which covers the planet—the famous "Martian Canals."

If you continue your observations long enough you will see that Mars, like earth, turns upon its axis once every twenty-four hours and a half; that the white spot is at one of the poles and changes in size exactly in tune with the Martian seasons. In the winter it is large; in the summer so small that at times it is invisible. Finally, you may suspect that there are changes in the so-called canals and the green-gray shadows—also seasonal.

So much for what you see. It is what we astronomers observe, except that, since no two persons ever see the same object exactly alike, we differ somewhat in our impressions of details. Thus, maps of Mars made by different astronomers frequently show wide variations in markings.

OUR next interest is to try to learn what the different lines and spots and shadows represent. For this the astronomer relies on his ingenuity in devising ways of using earthly knowledge and reason to translate what is visible. For example, fascinating new discoveries about the atmosphere surrounding Mars have come through applying knowledge of colors on earth to study of photographs of Mars made in colors. This method, recently employed by Professor W. H. Wright, astronomer of the Lick Observatory, is based first of all on the common observation that our atmosphere, illuminated by the sun, is blue in color. We know that the blue color of distant mountains is due to the great quantity of air in front of them. If, now, we look at these mountains through a red glass, their details are clearly visible; but if we see them through a blue glass they appear blanketed as if by fog.

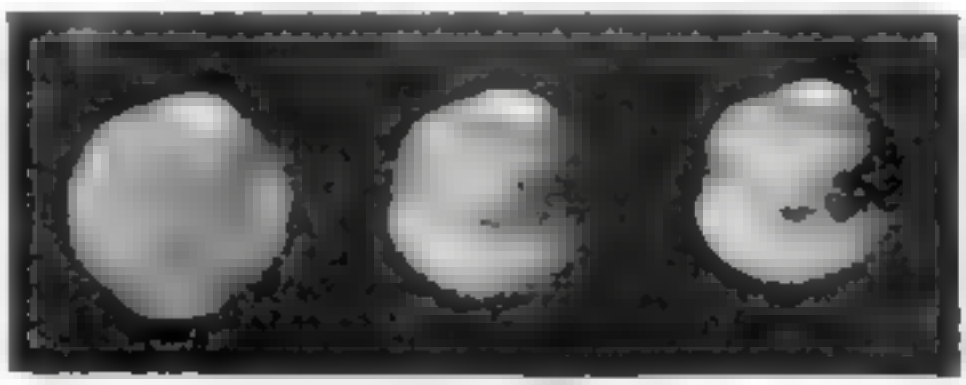
Similarly, in photographs of Mars taken in red light, the solid surface of the planet is prominent, while in blue photographs the surface is obscured. From this it is possible to deduce that the planet is surrounded by a shell of atmosphere

much like ours. The exact quantity of this atmosphere cannot as yet be calculated. Certain arguments, however, which seem quite plausible, have enabled me to estimate the atmosphere at the surface of Mars as about one twelfth that at the surface of the earth. This is equivalent to the pressure in our atmosphere at an altitude of eleven miles, or less than that encountered by the highest altitude flyers. The chief assumption of this calculation is that the composition of the Martian atmosphere is not far different from that of the earth—a view made more reasonable by the discovery, at Mt Wilson, that both oxygen and water vapor are present on the planet. This much appears certain—that the amount of oxygen available for breathing at the surface of Mars is about one thirtieth that upon the earth at sea level. Thus, a man breathing normally at twenty times a minute here would have to do so six hundred times on Mars to obtain the same supply of oxygen.

Two remarkable drawings of Mars, made by R. J. Trumpler, observing the planet through a powerful telescope. They show opposite sides of the sphere

CERTAIN blue photographs of Mars show a brilliant cloud effect invisible in the red. Evidently these are not water clouds, such as we find in our own atmosphere, for they would be opaque to the red light as well. Indeed, it is difficult to find any substance which would behave like the Martian clouds. Thus another mystery is added. In some photographs a belt of these strange clouds is seen to encircle the equator of Mars. It recalls the similar phenomenon upon our own sphere—the region of tropical storms.

By this time you will have seen and probably recognized the polar cap. There can be no doubt of its constitution, for its change in size and color and the fact that there is a cap at each pole prove conclusively that it is composed of some form of congealed water, whether of ice, snow, or mere hoar frost. The rapidity with which it melts evidences that the layer is not thick. The southern cap has been known to disappear entirely, the northern cap dwindles in size, but has never vanished. The explanation is interesting. When it is summer in the northern hemisphere, that is, when the north pole is tipped sunward, the planet is farther from the sun than when the southern summer is in progress. This tends to make the northern summers cooler.



Three comparatively close photographs of Mars, taken through powerful telescopes, showing ice, snow or frost (the very white areas) on one pole

Another interesting fact is that the southern cap is not exactly upon the pole, but shifted some hundred miles to the south. Obviously, therefore, it must be situated either upon an elevation or in a depression, it is difficult to decide which. One may argue that high altitude will tend to retard the melting of ice, owing to the prevailing lower temperatures; or, conversely, that water, tending to seek its level, would sink into a declivity and fill it to a greater depth, thus taking longer to melt. I am inclined to favor the latter theory. Since the atmosphere of Mars is probably very rarefied, I doubt if the elevation of the cap upon a high plateau could influence to so marked a degree the disappearance of the polar snows.

Prof. W. H. Wright, astronomer of Lick Observatory, who makes color photographs of Mars

As the caps melt, rifts appear in them and grow more marked until a piece of the cap will become detached and melt separately. The rifts appear in identical places each time the caps are vanishing, indicating permanent irregularities in the planet's surface.

Even though no one ever has seen a mountain on Mars, we know that the surface is not flat. The red color on the planet is to be attributed, in all probability, to the presence of iron oxide—rust—which is the pigment of most terrestrial rocks of that hue. We recall our own painted desert and it is not improbable that it somewhat resembles the Martian landscape.

In sharp contrast to the crimson background, we find the dark green-gray markings and fine network (canals) of the same color. Early observers, reasoning erroneously from analogy with the earth, thought the larger markings were bodies of water. The fact, however, that canal network may be traced distinctly in the darker areas is immediate proof that the latter are not seas. The view that both the large patches and the lines are vegetation has gradually been gaining weight, though it is not impossible that they are dried-up oceans and river valleys.

The apparent straightness and geometrical arrangement of the canals led the late Professor Lowell to support the theory that they were constructed by Martians to transport water from the poles. The thinness of the polar ice and the absence of large bodies of water attest the scarcity of that commodity, and one cannot but admire Lowell's ingenuity. But since the width of the canals often exceeds 100 miles, they cannot be waterways.

IT APPEARS from the photographs now that the canals are by no means as straight as most observers psychologically draw them. In places the lines are crowded, intersecting, without apparent system.

Recent photographs likewise show that marked changes take place on the planet. Three views, taken in 1909 at the Yerkes Observatory and in 1924 and 1926 at Lick, reveal distinct alterations in the markings. As for the temperature, the melting of the polar cap makes it almost certain that the surface is warmed at least to thirty two degrees F. Since Mars is about half again as far from the sun as is the earth, its average annual temperature would undoubtedly be lower than ours. The climate of our earth is greatly influenced by the oceans and the thick atmosphere. Water is about five times better than rock as a heat container. During the day the earth's moist envelope is laying up a store of heat which it radiates during the night. Mars has no such convenient foot warmer. Furthermore, our heavy atmosphere acts like a blanket, whereas Mars has relatively but a thin sheet. We may thus expect to find, for that planet, extreme differences between day and night temperatures.

Astronomers have been able to hitch electric thermometers (thermocouples, as they are called) to their telescopes and actually measure the heat from the planets. Such observations, made at the Lowell, Lick and Mt. Wilson Observatories, have proved conclusively that the temperature of (Continued on page 107)

Kakapo after the cadet class had lined up called Kaka to one side and gave him instructions. Whatever it was it had to be relayed

Kaka *and* Kakapo

What Happened When Ten Air Service Fledglings Obeyed and Followed the Bird Who Couldn't Fly

By ANDREW A. CAFFREY

Illustrated by Clayton Knight

KAKA and Kakapo, respectively, were not the family-given Christian names under which Lieutenant Perlin and Major Poe moved and had their being officially. But Cadet Booth Delano, being up in bug and bird-ology, had renamed them in that order: Kaka Perlin and Kakapo Poe. Apt epithets, too!

"Now, look here, Delano," somebody had said upon the occasion of the offhand, double christening, "you're over our heads with your bird lore. What's a kaka, to say nothing of a kakapo?"

"Well, you plebs know what is it a kiwi?" Cadet Delano questioned and stated at one and the same time. "All Air Corps birds know that a kiwi is a flightless fowl, an apteryx found in New Zealand. So, also, is the kaka a New Zealand bird, a parrot, while, strange as it may seem, the kakapo is the kaka's first cousin (through intermarriage with kiwis) and has well-developed wings but does not fly.

"Now Lieutenant 'Kaka' Perlin, as you've noticed during your weeks in this cadet class, parrots beautifully to his superior's first-parroting. And, after a strange fashion, Kaka can fly. Oh, not that he zooms and spins with the gay abandon of a light-hearted, lighter-headed cadet, but he does go aloft now and then. And here's to any man who goes up to the sky in ships.

"Kakapo Poe—Major Kakapo—has the biggest pair of chest wings on record, yet, like the other swivel-chair kiwis of Web Field, Kakapo flies not at all. But he talks much and loud, repeats the same thing day after day, and leads one to believe that he is the flyingest bird in the cage. That is, if one be not too gullible, which we near-citizens and far-from-soldiers are not.

"And poor little Kaka, the first lieutenant of the second part, comes to heel and, echoing Kakapo's every order, gets in bad all along the line. . . . Don't any of you high-class cadets ever become lieutenants if you can possibly make the grade of second-class private.

"This meeting will adjourn to the flying field afront the big steel hangars.

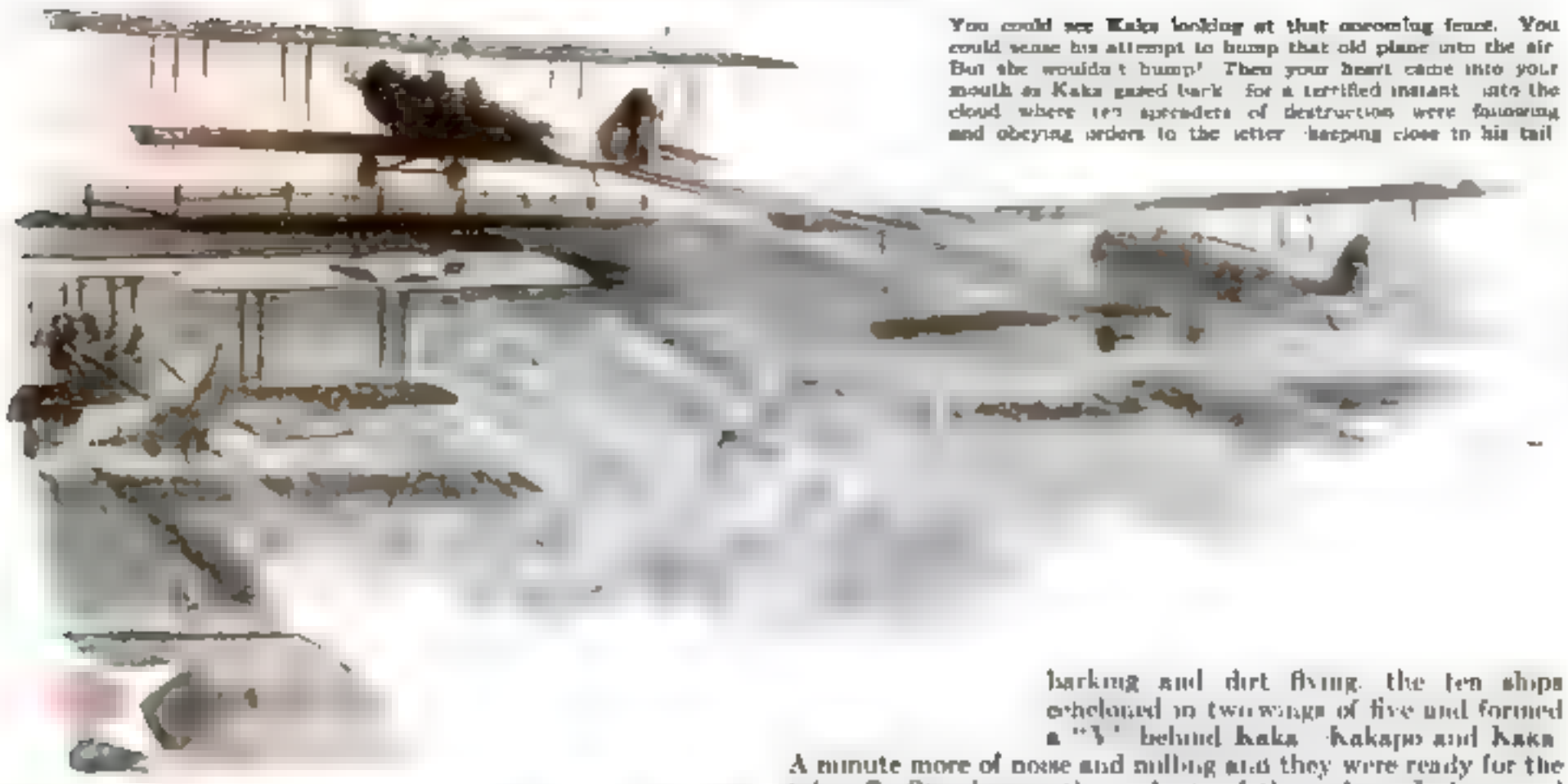
When the cadet class straggled out to the field for its ten o'clock session of air work Kakapo Poe and Kaka Perlin were already on hand and waiting. Kaka, assuming a military air that seemed to come hard, called the cadets to attention and lined them up for a talk. Kakapo Poe, pacing back and forth with the dumpy, heavy heave of a frog that had eaten too much, resembled something that no maker of soldier clothing would ever present as a well-dressed, snappy officer. To be exact, Kakapo, in a very unbirdlike manner, broke the scales at close to three hundred pounds. He was *some* man. And plenty loud.

KAKAPO—after the cadet class had lined up—called Kaka to one side and gave him instructions. Whatever it was it had to be relayed.

Says Kakapo to Kaka," Cadet Delano mused under his breath, "'You say that I said this.' Says Kaka to Kakapo, 'Yes, sir, I will, sir. I bow low, sir.'"

"Attention!" Kaka Perlin again called. The hard class came across with something approaching attention.

The major," Kaka went on, "has had any number of recent complaints from farmers near this field. Also, several of the neighboring towns have called his attention to the fact that you cadets are flying too low. This must stop!"



You could see Kaka looking at that oncoming fence. You could sense his attempt to bump that old plane into the air But she wouldn't bump! Then your heart came into your mouth as Kaka gazed back for a terrified instant into the cloud where ten spreaders of destruction were zooming and obeying orders to the letter keeping close to his tail

"Just a minute, Lieutenant Perlin," Kakapo called, and Kaka stepped back. The major spoke to him in a hard tone of voice. Then Kaka parroted

"The major—if this low flying is repeated—intends that court-martial proceedings shall be taken against the offender. Now keep this in mind! No more low flying—do you get that?" Then, turning to the lieutenant in charge of the class, Kaka said, "That will be all, lieutenant . . . start your air work."

AT THAT minute, from here or there or wherever they come from, a news-weekly camera man appeared upon the field. He kicked the several members of his tripod in as many different directions and put the black box on top, he was set. It's a way they have. Next, with the camera ready for action, the circular-motion man ran Kakapo and Kaka to earth just as they were about to quit the field. The mighty two stopped to listen. Camera-click is excitingly sweet music; and news-reel stuff is a symphony in any man's life. Kakapo and Kaka were coming back.

Kakapo said something to Kaka, and Kaka saluted and came a-running. By that time, ten planes, each filled with cadets, were warming up on the line.

"Hold those ships!" Kaka yelled.

"Said Kakapo to Kaka, 'Hold those ships,' and they were held," Cadet Delano mused. The cadets oiled their motors.

Kaka called the lieutenant in charge to one side. Then, going from plane to plane, the lieutenant told the flyers to fall out and line up for another talk. Cussingly, they did that thing.

"We're going to fly a close formation for this movie camera man," Kaka announced when the cadets had come to scratch. "With me, in the front plane and leading the flight, will be Major Poe. Now we want you cadets to do your best. We want a close, very Scotch formation. Every man in his place all the time, from start to finish. That means that we will take-off right in front of the camera in formation. And remember—no flyer is to leave this formation except through motor failure. You get right onto my tail at the gun and stick there! To your ships."

When the cadets had once more climbed aboard their ten ships, Kaka turned to the lieutenant in charge. "Lieutenant," he said, "the major and I will use your plane."

"My plane," the lieutenant in charge said, "is very tail-heavy. That's why I use it. It's too tail-heavy for the cadets."

"But I'm not a cadet," Kaka said.

"No, sir, lieutenant," Kakapo chirped up with reverse parroting, "Lieutenant Perlin is not a cadet. We'll use your ship, lieutenant."

"Yes, sir. Certainly, sir," the lieutenant said. "It is all ready, sir. But very tail-heavy, sir."

"That will be enough, sir," Kakapo snarled.

"Quite enough!" Kaka echoed.

With Kaka piloting the lead ship, the ten cadet planes followed him afield. Out there in the dust and rank grass, with motors barking and dirt flying, the ten ships echeloned in two wings of five and formed a "V" behind Kaka. Kakapo and Kaka A minute more of noise and milling and they were ready for the take-off. Standing in the cockpits of their plane, Kakapo and Kaka studied the line-up and were satisfied. Then, after the high-powered two had dropped into their seats and strapped up the safety belts, Kaka once more turned and held a dramatic hand aloft.

Ten watching cadets throttled and idled ten turning motors. Ten passenger cadets watched and waited; and Cadet Delano said to the cadet behind him, "Kakapo said to Kaka, 'You take me for a ride,' and Kaka said to Kakapo, 'Aye-aye, sir' and h-gosh he did." Delano was to fly one of the ships next to Kaka's rear.

The camera man waved his O.K. and started to crank. Then Kaka dropped his right hand and eased throttle to his motor with the left. Old Kakapo gripped the back cockpit's cowling with two hamlike, red hands and offered up an Army prayer. Ten cadets hit the ball and the flight was on its way. An army with orders!

Now, as a rule, a flight taking-off in formation does so more or less slowly. That is, the first plane gets under way and wins some speed before the next two—to right and left—make their start. Then, when those two get their tails up, the next brace comes along. In this way, with a group of eleven, the leader would have flying speed before the last of his followers were taxiing. And there'd be no danger—to the rear planes—because of the back wash of those out front; on a take-off, disturbed air is not so good—not what the flight surgeon orders at all!

But, during the forming of the grounded "V," the word had passed from ship to ship to obey orders. "Remember what Kakapo told Kaka to tell you—keep close on Kaka's tail from the very start. Don't let any light show between. And never quit this tight formation under anything short of motor failure. Also, recall that there's to be no more low flying."

WHEN those eleven propellers went to work, a yellow cloud of Web Field's best dust went into the sky. For a few seconds all the planes could be seen; then, one by one, they went out in blurs. But the roar and the rumble of many wheels spoke of progress, and Kaka's equipment proved that the flag was still there. He, speeding on, bouncing up and off the ground, plopping back again, was headed for the west-side fence. And the high wire fence came in, fastly.

"It's the major's weight," the lieutenant in charge of cadets could be heard explaining, "that's holding that old crate on the ground. I told Perlin she was tail heavy. And what I mean she is tail-heavy. Man, even when I'm flying her alone, it's an arm-breaker."

Web Field has a mile-long take-off, and that's a lot of runway. As a rule, a good pilot can pull the heaviest bomber off in less space than that. A mile! But it wasn't enough for Kaka.

Poor Kaka Perlin. Poor Kakapo Poe. You could see Kaka looking at that oncoming fence. You could feel him pushing the throttle against its ultimate "stop," and sense his attempt to bump that old plane into the air. But she wouldn't bump!

Then your heart came into your mouth and you felt sad as Kaka gazed back—for a terrified instant—into the cloud where ten spreaders of death and destruction were following and obeying orders to the last letter—keeping close to his tail. And more than that no man can do—keep close to the tail ahead.

And with them so close, Kaka could not "cut-his-gun" and abandon the take-off. That would mean several of eleven planes in one great smash-up. He had to go on, crowd the power and pull her out of danger. It was a man's-size job of frantic boot-strapping!

WELL, to this day, they'll tell you that Kaka taxied under that fence. But it's just as easy to tell the truth here—for once—so we'll say he went over. But it was only through force of character, or, maybe, because Kaka and Kakapo were born to die at the end of a rope and not in a plane crash. And, once they had cleared the wire, down the plane sank again.

And up, over and down went the ten following planes.

Now, with the dust out of their eyes, the cadets could more easily see and follow their leader. All eleven planes were off the ground - off and that's all. But the well-ordered flyers came in closer. Yes, the first two behind Kaka—one on either side—came in until the tips of their wings were pretty close to Kakapo's shoulders. And the old boy, showing the first sign of returning life, waved them off. Thinking that the major was being friendly, the flyers waved back. They came a little closer, if possible. To say the least, it was a beautiful piece of formation flying. Beauty, however, is pretty much a matter of mind. Kakapo and Kaka were not in the frame to appreciate it. Strange, eh?

Kaka's plane, as time went on, showed little sign of improvement. Its tail seemed to be pointing toward the earth in a manner suggestive of very bad omen, as if it were trying to tell Kakapo and Kaka—"That's where we're going, and soon!"

No kidding, that old ship was loggy. And it was just making enough headway to remain a-wing. It stalled. It fluttered. It did this and that and all the things a piece of air equipment should not do; and Kaka — poor Kaka!—tried everything in the book. Everything but the right thing: she failed to jettison Kakapo.

Beyond Web Field, in the direction of the flight, there are miles and miles of dismal cypress swamp. The cypress growth is not high, but it is plenty thick and mean. Underneath, it is also plenty wet. With such a wet aspect, below, Kaka could hope for no succor in the immediate future. Miraculously—and with a fool's dash of luck—Kaka managed to clear the first of the cypress trees and ride safely in above the wilderness. Then, crowding closer and yet closer, the brave boys behind came in nearer and tried to ascertain just what was keeping Kaka's tail down in such a laughable manner. From the distance, as all onlookers agreed, the eleven planes were now so well bunched that it looked like one single plane with a sweep-back to its wings.

Kaka, finding that the flying of that plane was "in the bag or the book" fell to thinking. He thought that the most he could do was to work this wild bunch around toward the field in a large circle. And, in this way, by winging up from the east, he might get a chance to shoot in for a landing. So he waited on a little left-rudder, pushed over on the heavy control stick, and hoped for the best. Through the tree tops, and always true to their leader, the cadets—perhaps to avoid loneliness—snuggled just a bit tighter.

The snuggling bothered Kaka and it bothered Kakapo. And Kakapo, having more time for such manifestations, waved madly. As a man, the cadets waved back. There is nothing like being on good terms with the C.O., and cadets are never uppish.

At about this stage of the game, a small spot in the northern sky grew larger and took on the appearance of a visiting plane. Ten minutes later—when Kaka had completed about half of his great circle—the spot that was a visiting plane came in and made its landing. The visitor was a high-ranking general who popped in now and then for an inspection. The general, noticing that all hands were looking at something other than a high-ranking general, became curious. He, standing upon his tiptoes and wondering, finally spotted the flight moving through the south-side trees. And the general, being quite sufficient unto himself, said nothing. The few who might have spoken to a general were not there, but in the lead plane; so, asking nothing, the big boy learned less. But, to see and study him, you'd know that the big boy was not overjoyed with what he was witnessing.

Twenty minutes later, several miles east of Web Field, Kaka had finished his great turnabout. He eased that ship into the west, snaked around a few extra-high trees, and hoped some more. Below Kaka, and looking wilder than ever, old Kakapo stared longingly up to the front cockpit and also hoped.

When Kaka approached the east fence of Web Field—and this is the truth in a strange place—he flew under the telephone lines on the state highway! And ten cadets followed him when he did so. And all the watchers held their breaths. All but the general; he held everything but his breath.

Now, coming to the high east-side fence, Kaka and Kakapo wished, hoped and prayed a little harder. They cleared the wire—and the awful ten flea-hopped behind them! Then—and you could hear Kaka sigh half a mile away—he cut his power and felt for the ground. But he felt not long; with that weight in the rear cockpit, the ground came right up and smacked them!

When the general landed and spotted the flight you could see he was not overjoyed with what he was witnessing

And the other ships, and all of them together, cut their power and landed as one.

When the ground came up and slapped Kaka's plane, the old ark cracked up like something that all Humpty Dumpty's men would be surprised at—there was nothing of that plane left but the number. The next two behind hooked wing tips into the crash and ground-looped in a swirl of dirt and dust. Then the next, and the next, did likewise. Of the eleven all but four had major injuries. And the field was a madhouse. And the maddest man in the madhouse was one visiting general.

SLOWLY, out of the dust and commotion of battle, Kaka and Kakapo could be seen to rise, feel their spare parts and get set to go into action. It was going to be a hard war on cadets.

But the general's presence became known. Kakapo, followed by Kaka, were bowing and scraping as they came toward him.

"General," Kakapo started to say, "General ——"

"Not a d—— word," the general bellowed.

"But let me explain, General. We ——"

"Not a word, Major Poe! I saw this whole show with my own eyes, Poe. And a disgraceful display of low flying and order-breaking it was! The thing that Air Corps is fighting hardest—low flying—and you, a major, leading such a troupe of outlaws as this!"

"But, General ——"

"Cut it!" the general barked. "Put it in your report. I've seen and heard enough!"

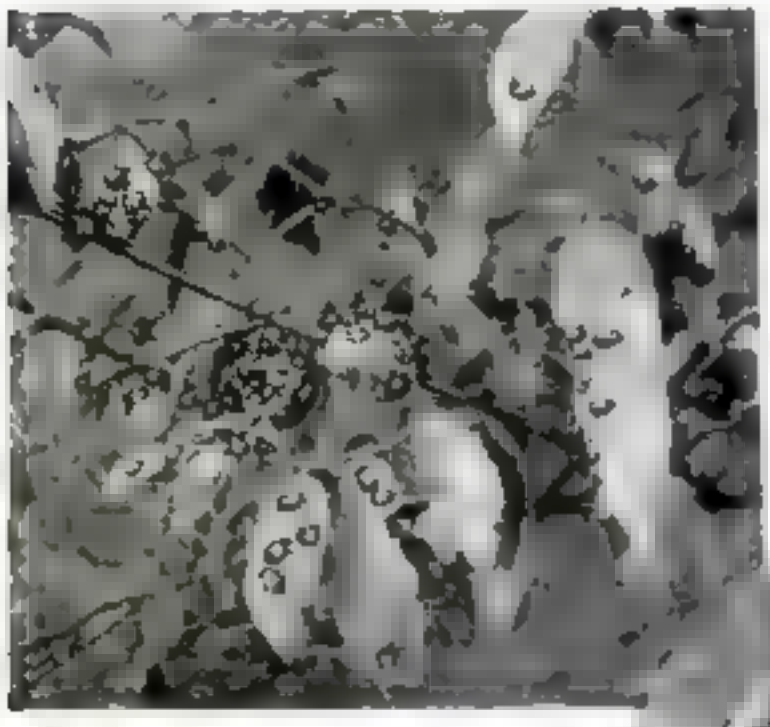
The general called his pilot and sailed away.

"And Kakapo said to Kaka, 'You tell the bad cadets not to fly too low,'" Cadet Booth Delano repeated at mess that noon. "And what did the cadets do? I ask you. Did they fly too low? No—is the correct answer—they flew one low, and that one was Kakapo. All of which checks the well-known truth that a kakapo is a New Zealand parrot, a talking parrot which has wings but does not fly. At least not high, not high enough to be called up."

Fighting Bad Bugs *with* Good

Millions of Insects Imported and Bred to War on Pests That Cause $800,000,000 Yearly Loss in U. S.

By JOHN WALKER HARRINGTON



At left: What a small colony of Japanese beetles can do to a peach tree, almost killed when the pests were found

Millions of eggs of codding moths, walnut and apple tree foes, are glued on these cards, then the parasites that kill moths are allowed to lay eggs on them. The cards are mailed by Stanley E. Flanders, Ventura County, Calif., entomologist, to any moth-infested area where the parasites hatch, multiply and war on the moths

WITH an armful of heather she came down the gangway of an ocean liner, just berthed at a New York City pier. The flower of the Scottish moors matched her sports suit—and she knew it. At sight of her a young man in green stepped eagerly forward and raised his feltern hat.

"I'll relieve you of the heather," he smiled.

"Well, perhaps I might spare just a sprig," she said, "but haven't you made a mistake? We don't really know each other, do we?"

"Permit me to introduce myself," he returned pleasantly, pointing to one of his coat buttons. "Inspector Federal Plant Quarantine. And if you don't mind, I'll take all of it. No foreign plants, shrubs or flowers can be brought to this country without special certificates."

At every port are stationed such officials. Their uniform looks so little like a garb of a service that without their dark green badges they might easily pass for returning tourists. Their coat buttons bear the eagle with outspread wings and the initials "U. S. D. A.—F. H. D." for United States Department of Agriculture—Federal Horticultural Board. These "Mister Greens," as they are called, see that no plants, seeds nor bulbs are admitted except under safe conditions. They are the patrols of the bug blockade—for as stowaways in flowers and the like come insects which lay waste the country. Even a branch from some shrub in the Argonne, brought by a returning American Legionnaire, may carry enough eggs to start colonies of bug guerillas.

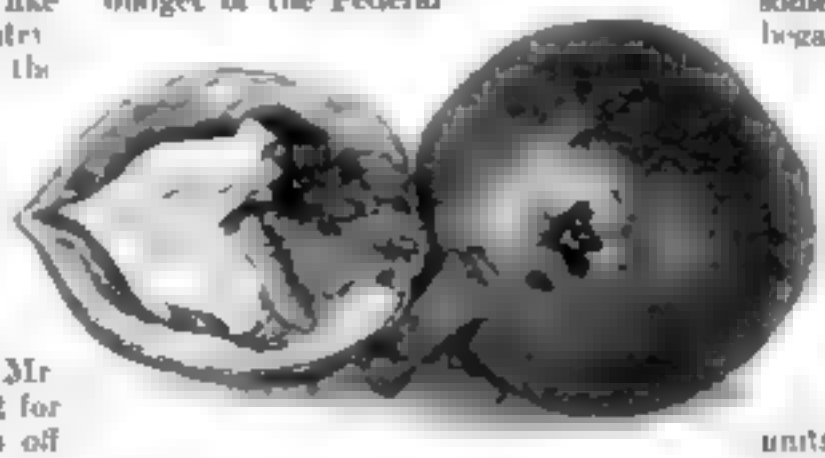
"THERE is no limit to the harm which can be done by bringing harmful insects in plant keepsakes picked up abroad," said a "Mr. Green" the other day. "Were it not for the customs inspectors, who tip us off whenever they find any growths in baggage, we would not be able to do as well as we do. Several weeks ago a colored man arrived with a bag wad of raw African cotton lint—as dangerous as so much gun cotton. The insects from it are so injurious that none is ever admitted unless fumigated. This passenger was going right down to a little town in Texas—in the cotton belt, at that.

"'What do you mean?' I asked, 'bringing in this nest of pink boll worms?'

"'I didn't mean no harm, Mr. Captain,' he explained, 'I bring it for my toothache.'

Had Uncle Sam not waited until 1912 to institute this ban, the loss of crops through insect pests would not now be more than the entire budget of the Federal Government. The damaging insects are practically all aliens. Some came with hawthorn from ancestral homes in England, or slipped in on linden shoots from Germany, or even in shamrocks nestling in a bit of the "auld sod." One of the worst pests was the gypsy moth which an astronomer brought from Europe in 1869 with the idea of crossing it with the silkworm to furnish raw material to our mills. Some of the caterpillars of the gypsies escaped from the scientist's place at Medford, Massachusetts, and in a few years most of the trees in the Bay State were minus leaves.

Foreign insects do great damage here because they find conditions more favorable than on their native heaths. Climate, soil, more abundant vegetable food—all are factors. The chief cause of their abnormal increase, however, is the absence of the natural enemies they had at home. Birds in America may turn up their bills at them, our toads and snakes give them the go-by. Only the war of bugs among themselves keeps down the noxious population. The worst enemy of insect pests are the almost invisible creatures, the parasites, which feed on them. The Federal Government, with the cooperation of the states, is importing millions of parasites from the native countries of the undesirable insect immigrants, and breeding and training native parasites to fight the invaders. Once a doubtful experiment, this plan of fighting bad bugs with good is now recognized as effective.



How the larva or worm of the codling moth works. At the right we see where the larva entered the nut and at the left its devastation on the meat inside

THE war on the Japanese beetles probably affords the best example. These pests first appeared in noticeable numbers in 1916 near Riverton, New Jersey, having come, Government experts believe, on the roots of iris from Japan. Half an inch in length, with bronzelike wings and green bodies, they might have passed for some harmless American variety. They began their first offensive after digging into an area of only three hundred acres. They now infest 9047 square miles, including all New Jersey and parts of Pennsylvania, Delaware, New York and Connecticut. They consume fruit, blossoms, flowers, shade tree leaves, shrubs and many vegetables.

To check this invasion, the Department of Agriculture organized a campaign, operating through its units the Bureau of Entomology and the Federal Horticultural Board and with the help of the states concerned. The chief of staff, veteran strategist in insect

wars, is Dr. L. O. Howard, head of the Bureau of Entomology. The field headquarters is the special Japanese Beetle Laboratory at Riverton, with L. B. Smith in command. Another station was set up in the Bronx, New York City, with L. B. Zimmer as executive officer.

All kinds of methods were tried to reduce the unwelcome visitants. One expert invented a sweet-scented mixture with which he atomized foliage. The beetles swarmed over the fragrant leaves and were killed by a poison spray. But this method was too costly.

Never was a quarantine more thoroughly organized and enforced, as the writer, who has a small farm at Tappan, New York, on the north line of the "regulated area," can testify. On every road last summer were "Bug Cops," as they are called. They permitted no loads of produce, trees, shrubs, earth nor manure to move without certificates that such had been examined and found free of the pests. Violations were punished by fines of $500. Sharp-eyed young men, embryo entomologists, the "Insect Scouts," searched fields, gardens and parks, bringing beetles into headquarters for examination. Road signs warned citizens of the dangers of the pests.

If Japanese beetles did not fly, more headway could be made against them. The females fly thirty miles and lay fifty or sixty eggs apiece, which before many months produce new colonies of the pests. What is needed is a parasol plane for each one, such as are now going into commission by the million—the parasites from Japan which are already showing their deadly work.

DR. HOWARD sent an expedition to Japan in 1920 to study the habits of the invaders and to find out what their enemies were. The Japanese experts were surprised to hear of the havoc in New Jersey. The insect had done no great damage at home. For days the American scouts could not find any of the bugs. Finally they employed two hundred women and children to help them, giving prizes and bonuses, and at last got what they sought—beetles which had been attacked by parasites.

The first parasite found was a small fly, which chases the beetle until she tires it out, and then lays fifteen to sixteen eggs on it. Maggots hatched from the eggs bore into the pest, kill it and then breed. The American entomologists sent to Riverton beetles on which eggs had been laid by eight kinds of parasitic flies, and also a wasp which feeds on the beetle and a large beetle of prey which fights its Nipponese bad brother, claw to claw, and eats him.

Smith, in charge of the Riverton laboratory, says five varieties of the newcomers were multiplied and turned out in the open air in colonies to attack the enemy. The most effective so far are the Tiphia wasps, for of the beetles caught near the laboratory twenty percent were infested by these parasites. Thousands of these wasps have been effectively transferred to various parts of New Jersey.

Corn bins where moths are raised to provide food for parasites being bred to war against moths in the fields. As the moths emerge they are collected by an ordinary vacuum cleaner

[Illustrating the percentage of losses of commodities in America, due to insects. The total is $800,000,000 yearly (less total $143,600,000

On the boring line are the larvae of the Dexia and the Prosena flies. The Centeter flies have now a spread of seventy-five square miles.

Despite progress against the Japanese beetle, the situation is still acute. Dr. A. L. Quaintance, Associate Chief of the Bureau, is much concerned over ravages of the beetles in the cornfields. It would be a serious situation if the bugs from Japan spread westward in 1928 and joined the corn borers against which the Government has another campaign, described in POPULAR SCIENCE MONTHLY for September.

Coming as stowaways in broom corn from Hungary and Italy received near Rochester, New York, in 1909, the European corn borers have pillaged thousands of farms in parts of New York, Ohio, and Ontario and beyond.

Against the corn borer the parasites have won medals for valor, especially the "Rileys," as the scouts call a species first described by a scientist of that name. To keep generations of borers yet unborn from leading the "life of Riley," this parasite buries her eggs in those of the pest. They are among the seven American varieties which war on the maize manglers, while the Government has imported eleven others.

Taken all in all, six kinds of parasitic flies have pretty well defeated the corn borer all through Massachusetts. The army of 1,167,000 foreign parasites sent against the borers in New England caused a heavier casualty roll than the native parasites did. The corps of 925,000 recruited overseas and assigned in 1926 to nine localities in the Middle West are multiplying and becoming effective.

L. H. Worthley, Administrator of Corn Borer Control, reports many European parasites and some from India and Japan sent against the borers.

Thanks to the parasites, much of the depredations of the gypsy moths have been stopped. The coming of the brown-tailed moth from Europe in 1897, of course, made things worse. That efficient parasite, Compsilura, recruited in ten European countries and in Japan, has kept these nuisances within bounds. Since its introduction in 1916, according to Julian J. Culver, assigned to fight gypsy, brown-tailed and white tussock moths, those pests have practically disappeared. It has also nearly exterminated the celery worm, the cabbage worm and the fall web worm in eastern Massachusetts.

When its strength is sapped by borers, corn is less able to resist the grain disease called smut. Miss Marion Griffiths, a U. S. plant pathologist, comparing good and diseased ears

THE pink boll worm, a native of India, which came by way of Egypt and Mexico to Texas, is very destructive in the American cotton belt. Its worst natural enemy is a mite, which would be worth encouraging more, but for its habit of biting human beings. Forty-five kinds of parasites, of which twenty-three were imported, assail the Mexican boll weevil.

All who have gardens and orchards know the San Jose scale, killed by a tiny beetle known as the lady bird, or ladybug, whose importation was described in POPULAR SCIENCE MONTHLY for last October.

The insect foes of insect pests live on their kill. They do not feed on vegetation; if they did they would be as dangerous as the enemies they are sent against.

Marconi—*the* Father *of* Radio

Inventor Who Amazed World with Transocean Signals in 1901 Now Predicts More Marvels

By ALDEN P. ARMAGNAC

ATOP a bleak Newfoundland cliff overlooking the December Atlantic, a young man sat at a queer-looking set of instruments. Wires and coils were grouped about him, while above the small building a kite darted and plunged, carrying aloft a thin wire. Telephones were clamped to the young man's ears. Then came three clicks that have made world history.

"Do you hear anything, Mr. Kemp?" asked the young man as he passed the receivers to his assistant.

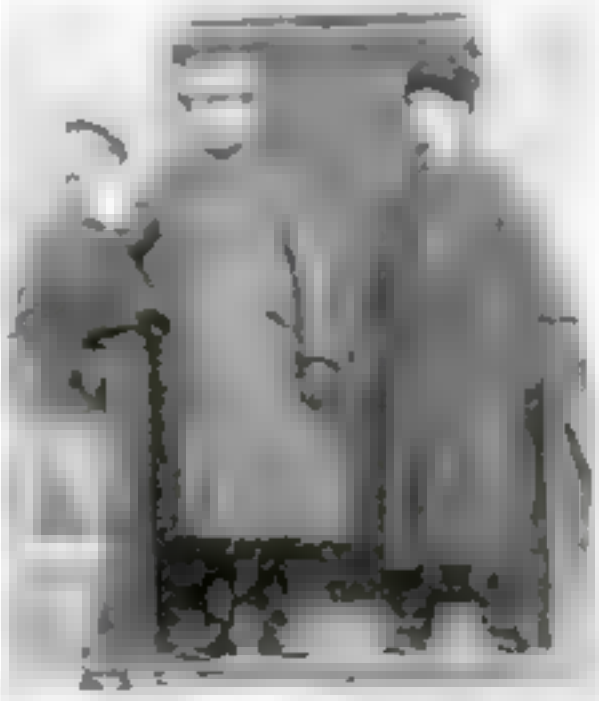
"Yes," was the reply, and Guglielmo Marconi knew that he had heard the letter "S" hurled by wireless across two thousand miles of ocean from Poldhu, England.

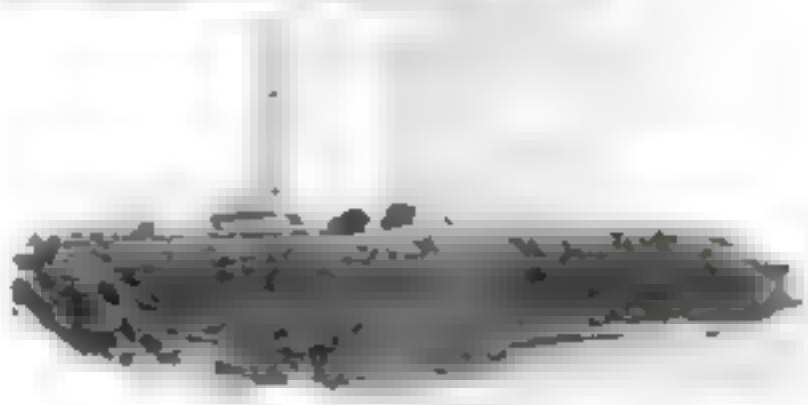
Today, twenty-six years since a wireless wave's first trans-Atlantic hop, Marconi finds us living in a world of radio. Broadcasting stations entertain us and the people of fifty-six other lands. Eighteen million radio receiving sets, our Department of Commerce tells us, bring music and speeches of famous men to 90,000,000 listeners the world over. The other day a photograph was dispatched by radio to far corners of the earth. Television is being perfected, and even radio power seems just around the corner.

Even as Marconi laid down his receivers after the first transocean signal, his mind was dreaming of these newest radio successes, but he knew then that the world would doubt his first achievement. It was not until three months later, when Marconi received whole messages on a ship taking him from England to Canada, that the last doubt disappeared. From that time on, progress of radio was rapid.

"Wireless telegraph" became "wireless telephone," then "radio" as we know it. Broadcasting stations came into being, then "beam wireless," modern wonder. Now radio waves steer airplanes and detect hidden metal ores.

DESPITE his achievement, it was not with Marconi that the idea of signaling without wires originated. In 1867 Professor James Clerk-Maxwell, British physicist, based a theory of transmitting electric waves upon earlier experiments of Michael Faraday. Twenty years later Heinrich Hertz in Germany generated by means of an electric spark gap waves that could be measured. Marconi developed Hertz's invention into a device of practical use.





Above Marconi, center, and his assistants, G. S. Kemp, left, and A. Paget at a far north experimental station for wireless in 1901. Below, Glace Bay, N. S., station, which received the first complete messages.

Legend has it that Marconi, at nineteen, then a student at Bologna, first thought of wireless because his sweetheart's Irish mother forbade their communication. All he has ever said is, "I wanted to communicate with some one with whom I could not otherwise communicate."

Marconi's first wireless patent, obtained in 1896, embodied a "coherer," long since replaced by vacuum tubes that used wireless waves to render a tube of iron filings a relay for electric currents and with it familiar coils and instruments before used by electrical engineers.

MARCONI went to England in 1896, set up experimental stations, and sent a wireless message across the Channel to Boulogne in France. Three years later he came to America to continue experiments and by 1901 twelve ocean liners were equipped with his wireless system.

In August, 1901, the first trans-Atlantic wireless station, with twenty 200-foot masts carrying its aerial, was nearing completion at Poldhu, Cornwall, when it was wrecked by a storm.

"I was extremely disappointed," Marconi said, but by the middle of November he had erected a makeshift aerial—sixty copper wires converging in fan shape at the bottom, suspended from a triangle of cables hung in the air. Again Marconi set off for America.

Inconspicuous press notices told of his arrival, in contrast with the columns that were devoted to him when he came to this country last fall. Marconi was wise for his age—he was only twenty-seven—knew that if he did not need his purpose to span the Atlantic he would be a laughing stock.

On Signal Hill, overlooking St. John's harbor, Marconi set up his apparatus. He must get a wire, a receiving aerial, into the air. A balloon with the first one was carried off by fierce winds. A huge kite bore the second up 400 feet and defied the elements. Marconi cabled the operators at Poldhu. They were to send the letter "S," three dots or clicks in the Morse code.

At half past twelve on that historic

(Continued on page 138.)

Guglielmo Marconi, wireless inventor, right, who received first trans-Atlantic signals and his assistant, G. S. Kemp, left, who confirmed them, show first crude type of receiver to Viscount Wolmer

So *the* Quacks Get Rich

Magic Collars, Electric Belts, and Mysterious "Cure-Alls" Lure Thousands, Who Might Have Real Wonders for the Asking

By MORRIS FISHBEIN, M. D.

FROM the earliest times there have been miracle men because there have been men who craved miracles. In time of disease, particularly of incurable disease, the human being apparently loses all sense of reason and is ready to rely on incantation and prayer. Figuratively and literally, he grasps at any straw. The motives of those who sell devices for the relief of pain or for the cure of disease do not in such times concern him. He craves wonders and is easily deceived. For this reason the story of quackery is a never-ending tale.

As rapidly as new discoveries appear in any field of science, inspired quacks adapt those discoveries to their exploitations. In 1796, electricity was much more of a mystery than it is today. Benjamin Franklin had flown his kite and the Leyden jar had been described in Holland. Everyone was interested in electricity and talking about its mysterious powers, but few actually knew anything at all about it. Elisha Perkins, born in Norwich, Connecticut, and graduated as a physician, developed on the theory of electricity two little metal rods, one composed of copper, zinc and gold and the other of iron, silver and platinum, although it has been asserted that they were probably just brass and iron. With these little rods three inches long, he claimed disease could be drawn from the body, particularly if the Perkins' tractors were drawn downward; drawing them upward might intensify the disease. They cost perhaps a shilling apiece to manufacture, but they sold for five guineas.

Perkins' tractors took the country by storm, exactly as did the visit of Emil Coué. Testimonials were secured from the chief justice of the United States and many other notables. George Washington purchased a set of the tractors for the use of his family. Eventually the tractors were taken to England by Benjamin Perkins, son of Elisha, and there the discovery won equal success. Finally two English physicians made a pair of tractors out of wood and fixed them up to resemble the authentic specimens. With these they produced cures as remarkable as those produced by the Perkinsonian tractors. When the fact was made known, tractorism disappeared as a science for the healing of disease.

The modern reader will laugh at the people that purchased the Perkins tractors, but today in almost any drug store one still finds for sale heel plates to be put into the shoes. One of these is made of copper and the other of iron, and the chart proclaims in glaring letters that by this means the electricity in the body is grounded and rheumatism disappears. Any druggist will tell you these are bought in equal quantities by economical Senegambians or prosperous bankers.

Perhaps the greatest quack of all times was Albert Abrams, of San Francisco, who departed this life in 1924. His story develops like that of Elisha Perkins.

DR. FISHBEIN is widely known as an interpreter of modern medical science. He is editor of the *Journal of the American Medical Association*, also of the health magazine, *Hygeia*, and is the author of numerous popular articles and books on medicine and health.

beginning to [illegible] seriously. Not long after Andrew Still began his teaching, he was visited by D. D. Palmer of Davenport, Iowa, who was at that time a traveling practitioner of magnetic healing. Palmer took over largely the conceptions of Andrew Still and from the hybrid of magnetic healing and osteopathy developed his school of chiropractic.

THE popularity of these short cuts in medicine resulted in the development by Albert Abrams of a system of practice known as "spondylotherapy," the term "spondylo" coming from the Greek word for spine and not from the better recognized "spondulix," referring to the coin of the realm. Briefly, spondylotherapy consisted of tapping the spine repeatedly and persistently with a rubber hammer until the patient became convinced that something had been done for his illness. With this conception, Albert Abrams developed a medical society, a medical periodical, a graduate school, and all of the other paraphernalia of medical promotion. Perhaps because he was not yet ready to go as far as Palmer and Still, spondylotherapy failed to bring him either the position or the returns that he sought.

Immediately after the beginning of the twentieth century, however, there came upon the scene a newer knowledge of electricity associated with the invention of the wireless telegraph and the radio. People began talking about tubes, waves and electrons. Just as in the time of Benjamin Franklin, the period was ripe for exploitation of this knowledge in the field of quackery, and to such exploitation Abrams devoted himself. In his technic, a drop of blood was secured from the patient and placed upon a piece of filter paper. To this blood sample was added a chemical reagent. Abrams claimed the ability to tell the religion of the person submitting the blood, and to diagnose disease by his methods from the handwriting of those long since dead.

Abrams leased his apparatus, exacting a contract that it would not be opened by the purchaser. Of course, curious investigators did open the boxes. It was found that the Abrams followers were inserting electric resistance into a circuit which could not oscillate, and therefore had no vibration frequency. Competent physicists who investigated the apparatus found it a jungle of electric wires violating all the rules of sound electrical construction.

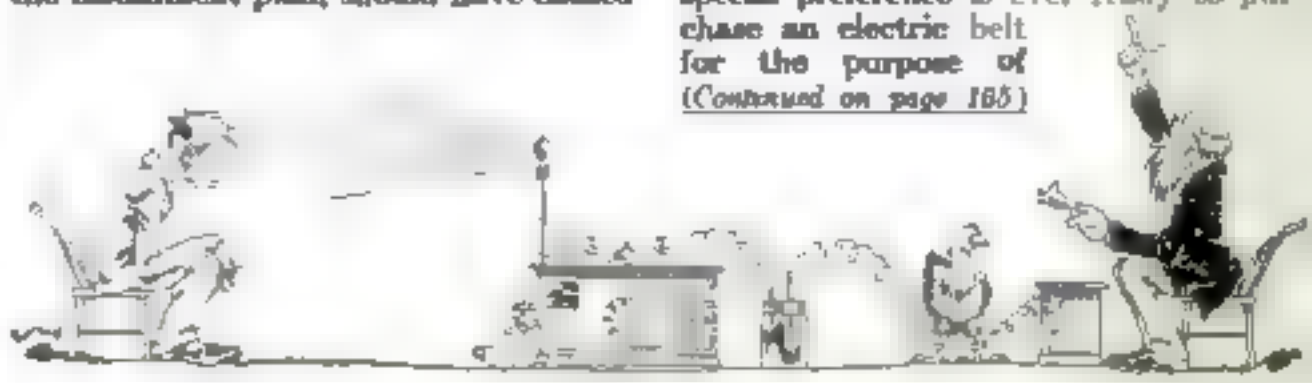
ON HIS death, Abrams left an estate of more than a million dollars made in a few years, but as with most peculiar methods of treatment, his cult died with him.

Soon afterward emerged one of the most romantic of medical quackeries, the I-On-A-Co, a device developed by one Gaylord Wilshire in Los Angeles and satirically designated the "magic horse collar." Certainly the early experience of Wilshire in the exploitation of socialism, including his magazine and gold mines on the installment plan, should have caused him to be wary of the public gullibility. He has secured testimonials from hundreds of people alleged to be suffering with arthritis, heart disease, diabetes, paralysis, cancer, Bright's disease, asthma, pernicious anemia, baldness and mental derangements.

Testimonials are not difficult to get for anything. It is reported that in one promotion campaign several quite distinguished ladies sold their portraits to a cold cream company for $5,000. The renowned Jack Dempsey for a consideration permitted the statement that nuxated iron permitted him to triumph over the once renowned Jess Willard. Who is "sanatogen," a combination composed of ninety-five percent of cottage cheese and five percent of glycerine phosphates, was offered to the public as a marvelous tonic and a general "cure-all." Testimonials were easily secured from artists, statesmen, tragedians, and litterateurs. The ordinary testimonial is hardly worth the paper it is written on.

In the wake of the notable quackeries that have been described comes a flood of similar quackeries promoted on a smaller scale. That class of the community for which Barnum felt such a special preference is ever ready to purchase an electric belt for the purpose of

(Continued on page 165)



The number of persons ready to be mystified by electricity seems unlimited. Craving miracles **health seekers sit spellbound** before Rube Goldberg contraptions and strange jungles of wires

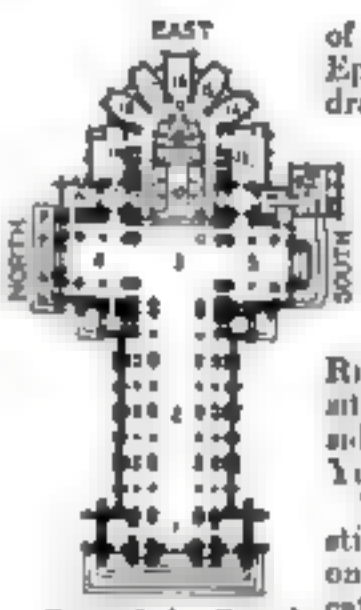
An architect's drawing of the Cathedral of St. John the Divine, third largest cathedral in the world, as it will appear when it is completed

Fifty Years to Build Church

Engineering Problems Mastered to Make the Cathedral of St. John the Divine Stand for 2000 Years, a Mighty Pile of Solid Masonry Unenforced with Steel

By JESSE F. GELDERS

Building on the cathedral today. One of the entrances now under construction



Form of the Cross in cathedral ground plan

HUNDREDS of spectators lined the way, watching the laborious progress of twenty-four horses, harnessed to a single load, straining against their collars.

Their burden was a granite column, thirty-eight feet long, six feet in diameter. It was carried low, between huge pairs of wheels, specially made nearly three feet wide so as not to cut too deeply into the streets. Yet before the destination was reached, one of them had crunched through the surface and caved in a storm sewer. It was gotten out, and the outfit moved on.

The ponderous stone was a section of one of eight great pillars for the sanctuary of the Protestant Episcopal Cathedral Church of St. John the Divine. It was twenty years ago that that odd procession made its way from a Hudson River pier to the site on Morningside Heights, New York City.

Today work is still going forward on the unfinished cathedral. It is to be the third largest in area in the world. Only St. Peter's in Rome, and the cathedral in Seville, Spain, will surpass it. Its cost will be about $20,000,000

Planned in the form of a cross, when completed it will offer an observer in the nave, or long arm, an unbroken vista of 500 feet, about two city blocks, to the pillars and chapels at the farther end.

At the crossing, where the two arms intersect, the ceiling will be 235 feet above the floor. A moderate sized church might be placed there, steeple and all. There are seventeen and eighteen story buildings in New York which could occupy the space, and never touch the ceiling or wall.

The time element alone makes the cathedral out-

(Continued on page 171)

Early work on the cathedral. First pillars and arches being erected in 1905, fourteen years after construction was begun

Dirigibles, tanks, bursting bombs and flares in night maneuvers in Maryland give vivid picture of the next war

Amazing Guns Hit Aircraft in the Dark and Hurl Huge Gas Shells—Invisible Rays Exterminate Whole Armies—Submarines Launch Dirigibles and Bombers

By GEORGE LEE DOWD, Jr.

CRASHING, rending chaos! Flame and smoke, sinister vapors pierced by searing invisible rays! Overhead myriad monster airplanes hurling bombs of hitherto unknown power! Beneath, tens of thousands of cannon firing half again as far as in the World War; hundreds of thousands of machine guns and automatic rifles spraying bullets a third farther than in 1918, thousands of charging tanks, swift now and carrying more and heavier guns; new and deadly gases, incendiary shells and bombs—and amid this inferno he has created, tiny man, pulling his bright new strings that cause the death dance of his monster, the next war.

Stanley Baldwin, Great Britain's Prime Minister, says:

"One more war in the West, and the civilization of the ages will fall with as great a shock as that of Rome."

Marshal Foch, of France, says:

"The next war will be a war of machinery rather than of flesh."

SO SAY many others, here and abroad. They are, to be sure, those who are specializing in producing materials for that kind of war—and are known as the "Scientific War Men." Some call them enthusiasts, devoted to the bright images of scientific achievement created by their own devotion. In this country, particularly, although the average American is an "inventive, mechanical cuss," the leading all-around soldiers of the Regular Army warn against taking their predictions too literally. Yet majority opinion among those thinking, reading, writing about the next war is that it will be scientific, and horrible, and destructive beyond our knowledge. To which most Americans now, nine years after 1918, may respond:

"Well, what of it? It can't touch us."

But science has destroyed our safety. That is the conclusion of quite a few scientific war men in this country. Lieutenant Maitland said the flight to Hawaii demonstrated that the United States was vulnerable to air attack. Major Gen. Mason M. Patrick, Chief of the Army Air Corps, said both Army and Navy knew this and "the oceans are shrinking."

Admiral W. S. Sims says our ports at least can be bombed by airplanes brought across the ocean by airplane carriers. They are swifter than battleships, and each can bear about fifty airplanes that carry bombs from 2,000 to 4,000 pounds in weight.

There was exhibited at the Sesquicentennial in Philadelphia, even if it didn't work, an airplane to be carried in a submarine. In the next war there will be supersubmarines, 400 feet long, carrying heavy guns, that can cross either ocean, raid coasts, go home, refuel and refit, and do it again! Such supersubmarines will have crews of a hundred officers and men.

Air attack will be mercilessly swift. Fleets of bombing airplanes will drop upon great cities bombs of a ton or more weight, carrying high explosives, perhaps gas, perhaps insidious disease germs. In London they are studying now means to protect the population from gas attack from the air, and are considering gas-proofing parts of the subways.

No wonder, for Captain B. H. Liddell Hart, British military writer, says French airplanes could drop a greater weight of bombs on London in one day than did the Germans in the whole World War.

GENERAL VON ALTROCK said recently in the *Militar-Wochenblatt*:

"In wars of the future, the initial hostile attacks will be against the great nerve and communication centers of the enemy's territory, against its large cities, factory centers, munition areas. The war will frequently have the appearance of a destruction en masse of the entire civil population rather than a combat of armed men."

Machine-gun practice at night with tracer bullets which burn in transit, enabling the gunner to direct his fire and find his mark. The picture shows a stream of bullets glancing off a target at Fort Des Moines

But the first blow will be struck in the air and followed immediately on the earth by a rather small, highly expert, well equipped army, traveling on caterpillar tractors and wheels, in armored tanks of speeds thrice those of the World War. They will strive to get around or through enemy's infantry and artillery and destroy his main nerve centres, headquarters, telephone centrals, radio stations, munition dumps, turning his army into a mob without coördination or supplies. It was revealed only recently that the British Army had adopted a similar plan, proposed by Col. R. J. F. Fuller well-known military writer for the campaign of 1919, had there been one.

The British, who first introduced the tank to an amazed German army in 1916—although Francis J. Lowe, an American, claims credit for himself and Edwin M. Wheelock of Winona, Minn., and Charles Tolles of Eau Claire, Wis., for the original suggestion—have now huge tanks resembling cruisers going twenty miles an hour, with four revolving turrets for machine guns and central turrets for three-pounders, which are supposed to be the finest land fighting machines in existence. Contrasting with these are baby one-man tanks controlled like motorcycles. America has a twenty-three-ton tank carrying a one-pounder and a machine gun. The French have a seventy-ton tank carrying a heavier cannon.

The British are so convinced that the tank is the land weapon of the future that Sir L. Worthington-Evans, Secretary of State for War, has announced that cavalry units will be reduced in size and pack horses will be replaced with mechanical vehicles for the transport of supplies.

American ordnance experts have been experimenting with an amphibious tractor to carry artillery and supplies.

What new strange forms may not further attack take? Not so many scientists and soldiers laugh at the "death ray" as one might suppose. In 1924 a young Englishman named Grindell Matthews came to light as inventor of that. He had lost an eye from emanations of the projecting apparatus. Possibly Matthews has not discovered a workable death ray, but that doesn't mean that nobody has.

THE French Government is experimenting with an invention that may stop the engine of an airplane in mid-flight—surely a defense against air raids. The discovery of the cathode ray by Dr. W. D. Coolidge, of the General Electric Company, is an indication of the possibilities in America.

Toward the end of the war, the Sperry aerial torpedo was just becoming reality. In the next war it seems likely that aviatorless airplanes and unmanned ships will be directed on bombing raids. David Sarnoff, Vice President of the Radio Corporation of America, recently said:

"Heavy charges of high explosive may be placed under important Government buildings, docks, factories and other strategically important points, connected by radio receiving equipment capable of detonating the explosives when a certain secret code signal is sent on a particular wave length. Any power that prepared in this way could send out the signal on the outbreak of war, and paralyze his opponent."

And John Bakeless, author of "The Origin of the Next War," says a German staff officer has just declared that "war-

A powerful mobile antiaircraft gun in action at night at Fort Tilden, N. Y., against an imaginary attack by planes. Mounted on a fast and heavy motor truck the gun is rushed to the point of attack. Searchlights point out the enemy and the gun fires every three seconds. Such guns have scored a hitting percentage of 9.15, and can send projectiles more than 13,000 feet into the air

A warlike scene at maneuvers at Camp Meade, Md., when the Army blimps *TC 5* and *TC 9* moved over tanks which they attempted to destroy with theoretical bombs without themselves being brought down by fire of anti-aircraft guns. Land and air equipment have advanced far in efficiency since the World War

fare with bacteria holds great possibilities."

With infra-red rays, those just outside the red end of the spectrum as the ultra-violet are outside the violet end, there is much experimentation here and in France. Dr. W. W. Coblentz, of the U. S. Bureau of Standards, has worked out a signaling system invisible to anyone not having a detector.

The new noctovision searchlight, invented by John L. Baird, opens spectacular possibilities. With its invisible infra-red ray it may become possible to light up enemy trenches, fortresses and cities at night without their knowledge and then to attack them.

If scientific war does fail to gain quick decision, then will come the war en masse, the war of extermination. Men, women and children will carry out the command "Work or fight!" Our Army General Staff has been preparing ever since 1919 and 1920 when General Pershing as Chief of Staff set most of the ablest officers who had served with him in France and those who had shown conspicuous ability here, at the job of planning defense in the next war.

LIEUT. General Sir Gerald Ellison says in "The Perils of Amateur Strategy" that "the wars of the future will be national, and more than ever the civil populations will be brought within the zone of actual operations." Such a war will call more and more for centralization of authority, dictatorship, and so it will be run, vast as it is, by fewer and fewer men—great supermen in authority if not in stature. That is the belief of probably the best known writer on war in English today, Major General Sir Frederick Maurice, expressed in (Continued on page 168)

Walk East *and* You Lose Weight

And Your Speed, Seemingly the Same, Is Faster, Mathematicians Now Explain

By THOMAS M. JOHNSON

A FREIGHT train going from Chicago toward New York weighs less and travels faster than when it is going back to Chicago. The answer is neither "Now I know one" nor "Go to your room." It is the mathematics of relativity's farthest reach of the human mind into the unknown—or, possibly, a mistake.

Such mathematics has been challenged but is considered undeniably true by some philosophers who are eminent mathematicians. They say that if a perfectly accurate clock could be moved through space at the speed of light, it would not show that any time had elapsed, that time as we know it simply could not exist in the experience of the clock moving so rapidly. Time varies with speed. It is slower in Ecuador than in Ireland. You have to do weird jiggings of reason to understand relativity.

But such stunts are exhilarating in company with Henshaw Ward in his new book, *Exploring the Universe*, published by Bobbs-Merrill. One of its many interesting chapters demonstrates that the Einstein theory may be no more mysterious than the motion of a second hand on a watch. Here is a story he tells to explain relativity:

A RUSSIAN professor of physics crossing the Black Sea westward mystified passengers and crew by weighing a chunk of lead repeatedly and carefully, then going back eastward aboard the same ship, still weighing, weighing, weighing. He was checking the statements of mathematicians that it would decrease in weight as it moved eastward.

If he had put that lead on a train from Chicago to New York going twenty-five miles an hour, it would actually have been going twenty-five plus 1000 or 1025 miles an hour because the earth rotates eastward 1000 miles an hour. When the train went back, westward, it would have gone only 975 miles an hour.

The lead has more tendency to fly off the earth when it goes east, for the faster the earth's surface moves, the more likely is any object upon it to fly off, hence the object's weight is less.

And did you know that because the earth moves so fast in its orbit—twenty miles a second, one nine-thousandth the speed of light—its diameter contracts two and a half inches? And if it got going as fast as light there would be no earth, mathematicians say, because there is no velocity greater than that of light.

Relativity started because this motion of the earth aroused the curiosity of Professor A. A. Michelson of Chicago. He wanted to know in what direction the Chicago Loop, say, actually moves, due to the earth's rotation on its axis, its revolution around the sun and its movement toward the constellation Lyra.

From a stone, floating in a vat of mercury, he raced rays of light reflected from mirrors, in paths at right angles, using delicate apparatus to register the smallest differences. Mathematics had indicated a difference of speed, but there was none. That meant a new theory of light, and startled the scientists.

Michelson made a more elaborate test to detect the earth's motion by light rays. He laid a quarter-mile square of twelve-inch pipe, placing mirrors and sending light rays on either direction to test speed difference. Again there was none.

Upon Michelson's observations is based the theory of relativity. If they are false, so is the theory. Some scientists have attacked both, but Ward declares the basic logic and resulting calculations of the theory of relativity are "the constitution and the cornerstone of physics."

The word relativity describes, he says, "not the new theory, but the fact that the old laws of physics were not universally true, they were true only in the limited sphere of inaccurate observation, they were merely *relative*. What the mathematicians have done is to derive formulas which shall be *universally true for all conditions of space and matter and motion*. A descriptive name for the new theory would be 'universality' or 'absoluteness.'"

Denying relativity is "just a theory," Ward says:

"Science has all along proclaimed that relativity rests on an *if*—*if* light does really behave as it seems to in the Michelson-Morley experiment. When it is shown that light does not so behave, science will profit by one of the most spectacular and useful demonstrations that the human intellect ever devised.

Nothing will be lost to science except a temporary supposition, which will be gladly discarded. Science will then set an example by which all the philosophers and critics and theologians might profit; holding no faith that is not subject to revision when a new fact arrives."

Making You Acquainted with the Atom

FOREMOST among those tackling the "small end" of the queer behavior of matter is Prof. Niels Bohr of Copenhagen, Denmark.

For his discoveries, that helped to upset the classical notions of electrodynamics, Prof. Bohr received the Nobel prize in 1922.

The cornerstone of all matter, the foundation on which all scientists must build their beliefs of the world's laws, is the atom whose picture Prof. Bohr paints for us. Like a minature solar system, it has a nucleus surrounded by spinning electrons. Sudden "hops" of these electrons, Bohr has discovered, from an outer to an inner orbit, release the energy that gives birth to light.

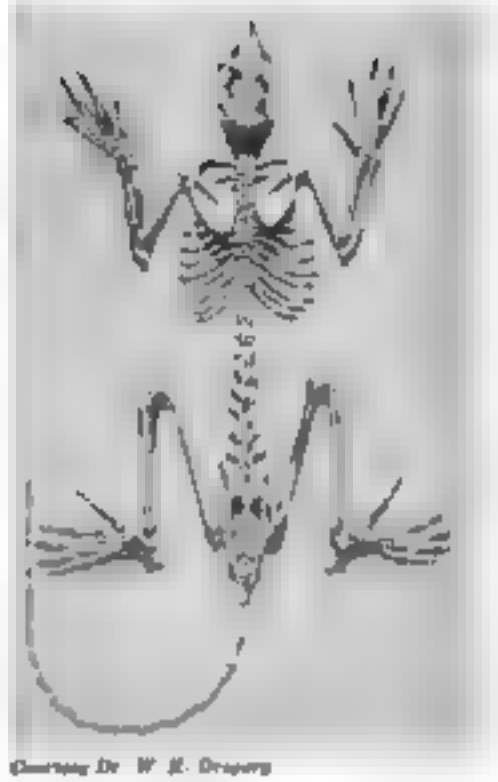
As an illustration of the way in which these discoveries help straighten out the puzzles of our imperfect knowledge, an offshoot of the laws of relativity, the "quantum theory" proposed by Planck and later twisted about to fit Einstein's theory of relativity, has at last been harmonized by Prof. Bohr with actual spectra seen through a spectroscope. This "quantum theory" deals with the way in which an electric light, a gas stove or an atom emits "chunks" of heat or light, with certain changes. Bohr has shown how its application clears up such mysteries as the splitting of light from hydrogen gas by an electromagnet.

A skeleton of a modern man, above, and a 50,000,000 year-old fossilized skeleton of a monkey, the *Notharctus osborni*, at the right of this page, show how man has developed. Note longer limbs, shorter body and larger skull for the expanded brain

Sir Arthur Keith Says:

Darwin Was Right

Chief of British Scientists Declares Mass of Data Shows Man Rose from Among Apes



Courtesy Dr. W. K. Gregory

By EDGAR C. WHEELER

EVOLUTION is in the news again. In the city of Leeds, England, a few weeks ago the British Association for the Advancement of Science witnessed one of the great moments in a world-famous trial, bitterly contested for more than half a century—the trial of Charles Darwin and the theory of evolution he first propounded.

In silent attention they heard the foreman of the jury state the issue and pronounce the verdict of modern research:

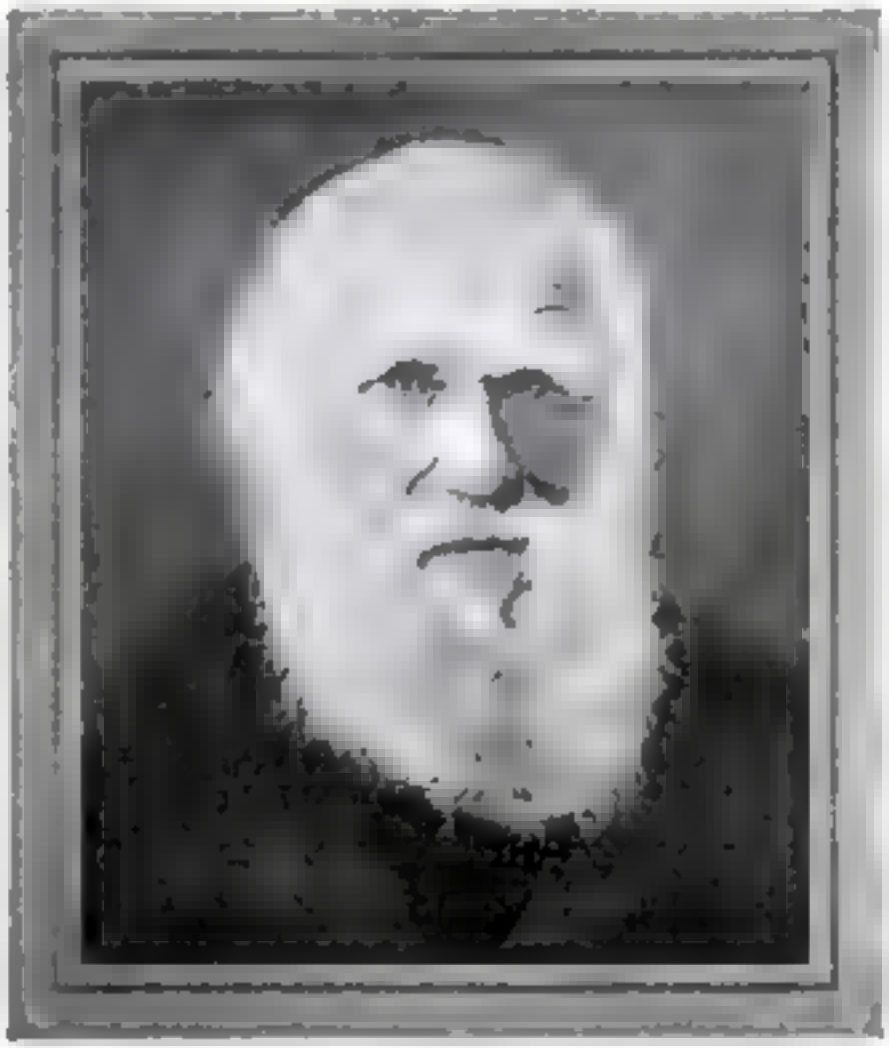
"Was Darwin right when he said that man, under the action of biological forces which can be observed and measured, has been raised from a place among the anthropoid apes to that which he now occupies?

"The answer is Yes! And in returning the verdict I speak but as foreman of the jury—a jury which has been empaneled from men who have devoted a lifetime to weighing the evidence."

THE man who made the pronouncement was Sir Arthur Keith, president of the Association, recognized as one of the most eminent students of man and his origin. His words echoed around the earth. They were momentous, not only because they summarized the opinion of modern science on an issue that has been debated for the span of a lifetime, but because of the very circumstances in which they were spoken.

For Sir Arthur's emphatic "Yes" was uttered from the same platform in Leeds where, sixty-nine years before, one of his most distinguished predecessors, Sir Richard Owen, foremost anatomist of his time, had poured scorn on the idea that man and ape could have common ancestors!

Then, in 1858, as Sir Arthur recalled, the audience "was convinced almost without a dissentient that man had appeared on earth by a special act of creation. Whereas," he added, "the audience which I now have the honor of addressing, and that larger congregation which the wonders of wireless bring within the reach of my voice, if not convinced Darwinists, are yet prepared to believe, when full proofs are forthcoming, that man began his career as a humble primate animal."



Charles Darwin, denounced in 1858 for declaring man had risen by evolution from among the apes, and vindicated in 1927 by science, which has added apparently irrefutable evidence to his own proofs

In sixty-nine years Darwin's amazing conception of creation has remained to be vindicated by the same exacting body of scientists which once ridiculed. And to the world at large has come an understanding of the majestic idea of man not as a creature cast in a mold like a toy in a metal shop, but as one reaching beyond his animal cousins to heights of intelligence and enlightened power through Nature's miracle of endless change.

And yet, strange to say, the evidence which has so altered the whole course of history is entirely circumstantial. Science never has, and possibly never will, discover direct proof linking man and the ape in common ancestry. Instead, it has assembled hundreds of circumstantial proofs—in the soil of ages past, and in the teeming life of the present—which seem to point unmistakably to the one conclusion.

Darwin, master detective of science, began the collection of this mass of evidence. With a genius for keen observation, he scrutinized the countless forms of life about him—the animals, plants, birds, trees, insects and strange creatures of the sea. He traced their life history and compared one with another

IN ALL he found the same laws of evolution at work. On the very day that Sir Richard Owen denounced the idea that man was "merely a transmuted ape," Darwin worked on the first chapter of a book embodying his observations. In "The Origin of Species," he described his theory that Nature evolves new forms of life from old by the processes of natural selection—by choosing for survival those individuals and races best equipped to cope with their surroundings. This he followed with other works, including "The Descent of Man," in which he traced mankind back to beginnings among the humble animals. It was a history based on circumstantial proof drawn from living documents; on painstaking analysis of the body, behavior, and life record of man, as compared with those of animals resembling him.

"Fifty-six years have come and gone since that history was written," said Sir Arthur. "An enormous body of new evidence has poured in upon us. We are now able to fill in many pages which Darwin had perforce to leave blank, and we have found it necessary to alter details in his narrative; but the fundamentals of Darwin's outline of man's history remain unshaken. Nay, so strong has his position become that I am convinced that it never can be shaken.

"All the evidence now at our disposal supports the conclusion that man has arisen from an anthropoid ape not higher in the zoölogical scale than a chimpanzee, and that the date at which the human and anthropoid lines of descent began to diverge lies near the beginning of the Miocene period. On our modest scale of reckoning, that gives man the respectable antiquity of about one million years."

The evidence falls into two chief groups first, the many amazing points of resemblance in bodily structure and life development between living man and the anthropoid apes—the gorilla, chimpanzee, orang-utan and gibbon; second, the fossil records of ancient men and their resemblances to the anthropoids.

Keith has listed fully 100 distinct features of anatomy common to both man and the apes which are not found in the tailed monkeys. Chief among these is the surprising similarity in brain structure.

"So alike are the brains of man and anthropoid," Sir Arthur declared, "that surgeons and physiologists transfer experimental observations from one to the other. Thousands of anatomists and physiologists have studied and compared the brain of man and ape; only a few months ago Professor G. Elliot Smith summarized the result of this extensive inquiry as follows:

"'NOSTRUCTURE found in the brain of an ape is lacking in the human brain, and, on the other hand, the human brain reveals no formation of any sort that is not present in the brain of the gorilla or chimpanzee. The only distinctive feature of the human is a quantitative one.'

It is just this difference in brain quantity, in the expansion of all those parts found in the ape brain, Keith tells us, that has given man his wonderful powers of feeling, understanding, acting, speaking and learning.

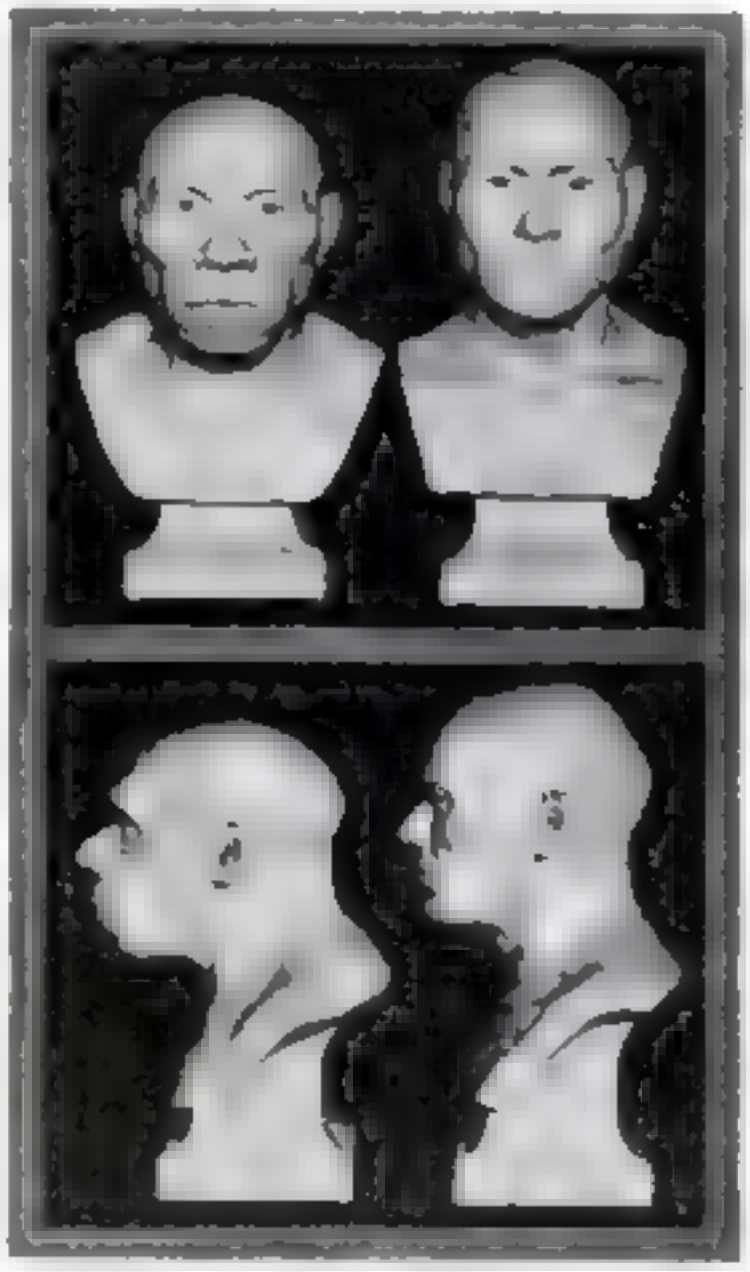
Darwin, after years of painstaking and exact observation, succeeded in convincing himself that immense as are the differences between the mentality of man and ape, they are of degree, not of kind. Prolonged researches made by modern psychologists have but verified and extended Darwin's conclusions. No matter what line of evidence we select to follow—evidence gathered by anatomists, by embryologists, by physiologists or by psychologists—we reach the conclusion that man's brain has been evolved from that of the anthropoid ape and that in the process no new structure has been introduced and no new or strange faculty interpolated.

Other striking points of similarity are these.

The blood of man and that of the great anthropoid apes, tested by exact methods of determining their affinity by chemical reactions, have been found to give almost the same reaction.

The anthropoids are susceptible to the same diseases, and their body tissues react the same way as man's to poisons, stimulants and sedatives.

Bone for bone, muscle for muscle, organ for organ, the structure of man is closely comparable to that of the apes. The chest and forearms show distinct marks of transition from a four-footed climbing animal to a four-footed creature that uses its forefeet as hands for grasping food. The feet are remarkably alike. Even vestiges of the muscles which give the ape its ability to grasp with its thumb-like big toe are possessed by human beings. Indeed, many persons are actually able to grasp objects in this way. Again, a small muscle known as the peroneus tertius, long believed to be peculiar to the human foot, has been discovered in recent years in the feet of at least two gorillas. One of these discoveries was made by Dr. Dudley J. Morton, of Yale, while dissecting a foot of the famous trained gorilla, John Daniel I.



Courtesy of Dr. J. H. McGregor

Busts of the Neanderthal man of 40,000 years ago, left, and the Cro Magnon, 15,000 years ago, right, reconstructed from their skulls. The evidences of higher intelligence and feeling are seen at a cursory glance

Like human beings, the ape can boast a vermiform appendix. Keith tells us that chimpanzees in captivity actually have been known to develop appendicitis, a distinctly human ailment.

In the processes of reproduction and the development of offspring, the similarities are equally striking. Even the simple germ cells from which new life springs are closely alike in man and anthropoid. The same elaborate processes that mark the beginning of complex embryo life occur in both, and are found in no other animals.

Comparison of the teeth of men and the anthropoids, both modern and ancient, have revealed still further evidence of common origin. Dr. William K. Gregory, of the American Museum of Natural History, a leading authority, recently declared:

"In the light of these and similar researches and in the total lack of real evidence to the contrary, we may regard Darwin's conclusion that man is of an offshoot from the anthropoid stem as one of the most abundantly documented inferences in the whole field of biological science."

But most fascinating of all the corroborative evidences for Darwin are the discoveries, since his death, of the fossil traces of prehistoric men and their stone implements.

"If Darwin was right," said Sir Arthur Keith, "then as we trace man backward in the scale of time, he should become more bestial in form—nearer to the ape. That is what we have found. The evidence of man's evolution from an apelike being, obtained from a study of fossil remains, is definite and irrefutable."

Oldest and most primitive of the early forms of humanity thus far discovered is the famous Java Man, called Pithecanthropus Erectus or Ape Man, believed to have lived at least half a million years ago. The unearthing of his fossil remains—the top of a skull, a thigh bone and two teeth—in a river bed in Java in 1891, is regarded by Keith and other evolutionists as having thrown the greatest light on man's ancient ancestry. They reveal a creature possessing a strange combination of man-like and apelike features. "The thigh bone," says Keith, "might easily be that of a modern man, the skull cap that of an ape, but the brain within that cap, as we now know, had passed well beyond the anthropoid status."

THESE remarkable fossils were studied not long ago by Dr. J. H. McGregor of Columbia University, member of the staff of the American Museum of Natural History and an authority on prehistoric restorations. He found that while the inside of the skull cap indicated a brain smaller and more apelike than any human brain, the development of the regions governing articulate speech indicated a man possibly just learning to talk. In outward appearance, the Java Man must have been distinctly apelike, yet the straightness of the thigh bone showed him to be a man who had learned to walk erect.

Next in point of antiquity are the remains of the Piltdown, or Dawn Man, who lived somewhat later than the Java Man, probably less than half a million years ago. They indicate that men of that far-off period while still displaying outward features of the ape, had acquired a definitely human brain. Next come the Heidelberg Man, somewhere about 250,000 years ago; Neanderthal Cave Man, 40,000 years ago; Rhodesian Man, 20,000 years ago, and finally the Cro-Magnon Man, 15,000 years ago.

In the Cro-Magnon anthropologists see evolution culminating at last in modern man. If you compare Dr. McGregor's remarkable reconstructions of the Neanderthal and Cro-Magnon men, reproduced with this (Continued on page 140)

Clothes Woven from Rock

Asbestos, the Strange Mineral Textile, Alone Enables Man to Make Flame His Obedient Slave

By ORVILLE H. KNEEN

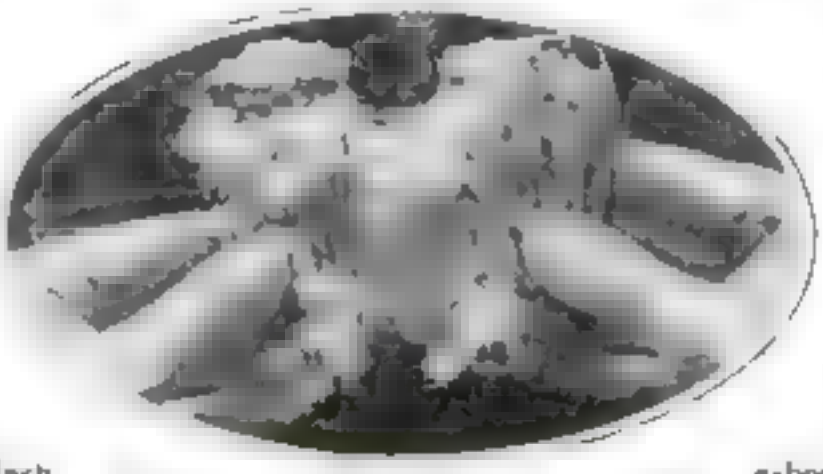
THE Shell oil officials breathed easier. With 2,460 feet of ten-inch pipe securely cemented at the bottom, they felt their newest well was safe against blowing out, the bane of the oil driller's life. No oil well in history, once cemented, had ever blown out. As they were congratulating themselves the cement plug shot skyward and a geyser of oil and gas roared six hundred feet into the air to be transformed in a flash into a pillar of flame topped with dense black clouds of smoke and running fiery disaster. A flaming torch with millions of cubic feet of gas and oil going to waste.

They wired for Alexander. Alexander the dynamiter. He came and looked and called a "fireproofing" specialist, and together they essayed the most daring exploit in the annals of fire-fighting, a masterpiece of sheer courage in a profession where courage is commonplace.

Clad in fireproof garments—hoods, jackets, overalls, boots, gloves—and shoving fireproof sheets before them, they built at the base of the towering flame a wooden platform covered with fireproof board and set thereon a hundred pounds of dynamite, paying out fireproof wires attached to it as they retreated.

ALEXANDER looked back. The platform was tipping. If it fell the explosion would fail of its purpose—to blow the flame away from the well. If Alexander and his aids went back and were there when it exploded—

So in seconds that seemed a breathless age to the onlookers these men went back and righted the platform and retired. Then by the fireproof wires the dynamite—enough to wreck a town—was detonated. Derrick, machinery, buildings were wrecked, a new well must be drilled, but the fire was out and the oil was saved, thanks to the strangest material in Nature, asbestos—the only mineral, the only rock that can be woven into fireproof garments and molded into instruments impervious to flame.



The mineral cotton. Crude asbestos looks like rock. It is rock, but pulled apart it is found to be of myriad fibers fine as finest silk or cotton

With asbestos armor and tools men can fight the fiercest fires known since first the disgruntled Prometheus stole the pyric secret from the gods or since primeval man discovered it. That is why when oil wells have flamed asbestos clothes and shoes have been rushed by Johns-Manville Inc., from Chicago and New Jersey by air mail as far as the Wyoming fields. That is why even the messenger dogs of forest rangers in California are clad in asbestos coats to [illegible] flames.

Some have thought the three who survived Nebuchadnezzar's fiery

A book [illegible] among the mistranslations of [illegible] fireproof [illegible] worked to conquer [illegible]

furnace were clad in asbestos. Ancient writers tell of a "stone which is carded and woven to form handkerchiefs" for emperors, the fabrics "cleansed by casting them into the fire." Corpses of royal Romans were sometimes wrapped in asbestos that their ashes might be preserved after cremation.

An ancient Greek writer tells of a lamp of gold for the statue of Athena with a wick of unburnable "karpasian flax." The Greek word asbestos means unextinguishable. Eskimos, finding asbestos in Labrador, have long used it for lamp wicks.

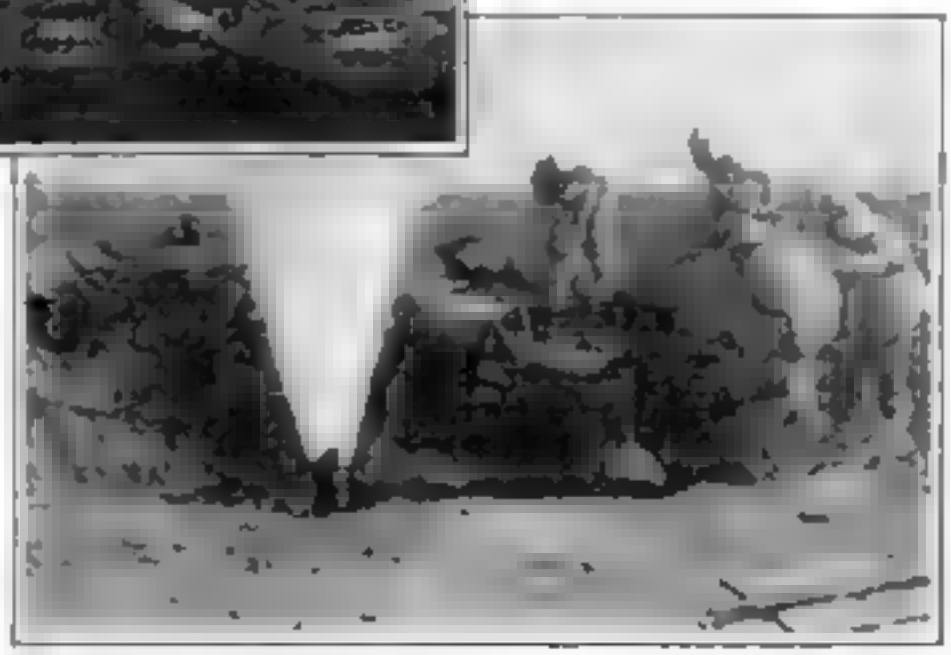
Marco Polo's countrymen only laughed when he brought tales, in 1295 A.D., of Tartars who had clothes made from the skin or hair of a mythical salamander, which lived only in fire. Polo learned that the material was really "earth-flax," mined in the Ural Mountains as it is today, dried, powdered and woven. Magicians, he said, cleansed it in fire. Four centuries before, the Emperor Charlemagne performed the same miracle for his guests with his tablecloth.

THIS mystical material, "fibrous and crystalline, elastic and brittle, heavy as rock in its crude state, yet as light as thistledown when treated mechanically," has withstood the heat and enormous pressure of volcanic fires and earth adjustment, apparently without alteration. Even fusion temperature cannot make it expand or contract. Since the earth was [illegible] these veins of silky fibers have seemingly survived when the hardest rock has worn or melted away.

Such everlasting qualities lend color to a story from the Canadian woods, not far from where most of the world's commercial asbestos is mined. An Englishman who had worked in an asbestos factory in England came to work in the woods. One evening the French Canadians saw him cast his socks into the hot stove and a few moments later draw them out and put them on again. They promptly decided him to be either the devil himself, or a devilish assistant, and refused to stay on the job unless he should be instantly dismissed.

"You are," a well known asbestos man told me, "almost surrounded with asbestos. Modern comfort and convenience would be inconceivable without this mineral curiosity.

(Continued on page 174)



All photographs by Johns-Manville, Inc.

In suits, hoods, helmets and boots of asbestos cloth these men defy the killing heat of a burning Wyoming oil well to prepare at the base of the gushing flame a dynamite charge that will extinguish it. Without this armor, woven from fibrous rock, there would be no approaching the blaze

Welder—New Tailor *of* Steel

Also a Carpenter, Cutting and Fitting the Metal and Fusing It Silently into Machines and Even Buildings of One Solid Piece

By L. G. POPF

Rail repairing for rapid transit and street car passengers is brought by the U. S. Bureau of Standards and the American Electric Railway Association in experiments on a welding fast joints to eliminate air as the wheels move from rail to rail

"THE clatter of steel construction is growing unbearable. It is making hotel and apartment rooms all but unlivable. It is disturbing our work and shattering our nerves. It is becoming a real menace to public health. What can we do about it?"

Such, in effect, was the statement of Dr. Louis I. Harris, Commissioner of Health in New York City, a few weeks ago, when he called a group of engineers into his office in an effort to find a solution.

He did not have to inquire far. The engineers, almost to a man, assured the commissioner that an easy remedy was at hand in the substitution of the welding torch for the riveting gun in joining steel beams and girders. "The deafening clang of riveting can be silenced for all time," they told him, "whenever builders can be induced to discard present methods of construction and employ the remarkable processes of welding recently developed in engineering laboratories."

Soon, they prophesied, the ribs of great skyscrapers and other structures of metal, will be knit together not by pounding hammers, but by silent needles of flame. By the proof of scientific tests they revealed that welded joints in metal construction not only save costs of material and labor, but can be made stronger and more durable than those fastened by rivets.

Once the breaking of a motor car frame meant long loss of the use of the car and often great expense in substituting a brand-new piece for the broken part. Here an electric welder is joining the severed parts, making the damaged piece as strong as new

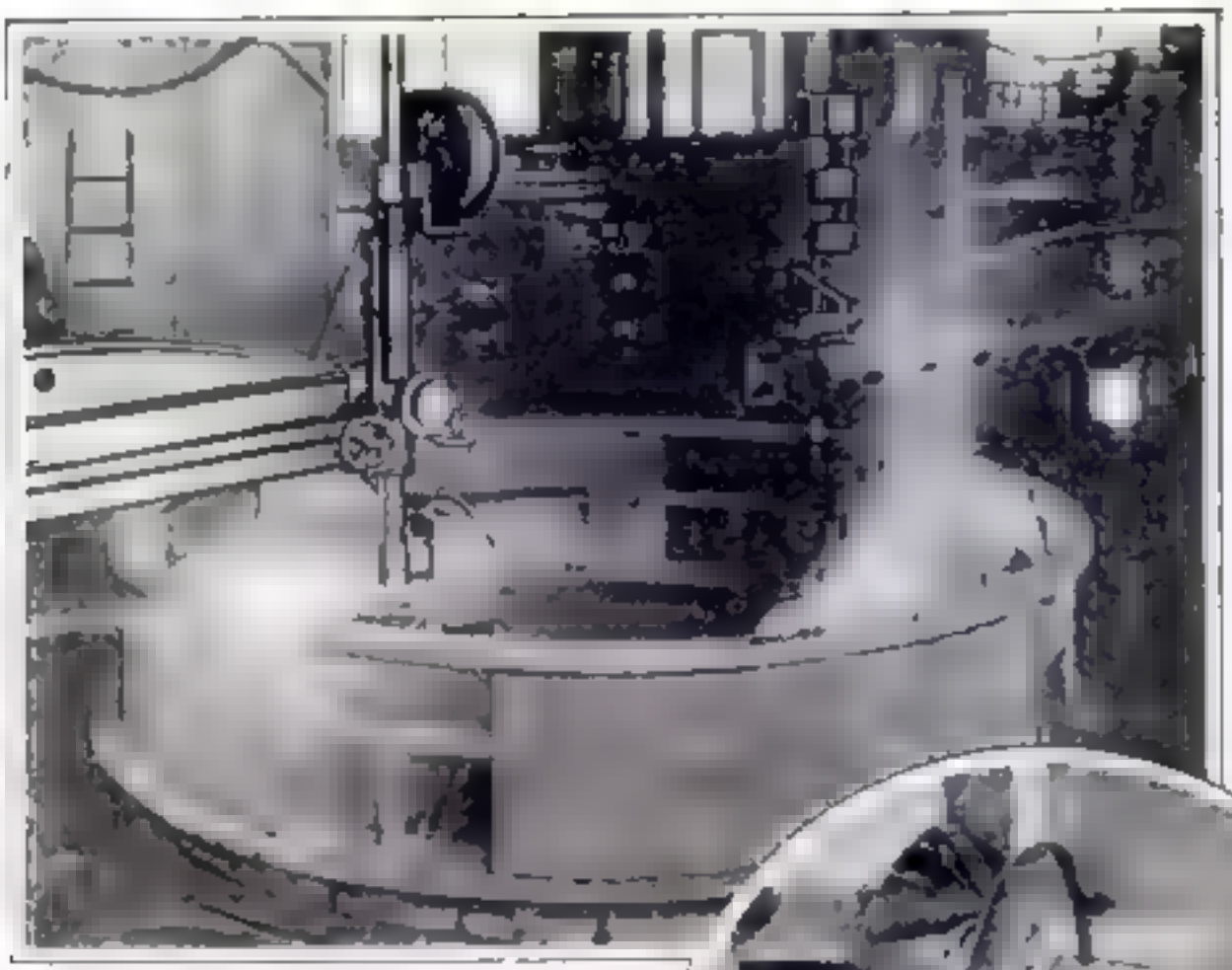
THUS recent effort to silence the din of a big city is only one evidence of the revolutionary changes being wrought throughout the metal industries by the new science of metal carpentry. The boiler factory, once the synonym for ear-splitting racket, now becomes a peaceful place where automatic welders, working quietly as seamstresses, bind metal edges together with electric arc or oxy-acetylene flame. In machine manufacturing plants the iron foundry with its furnaces, patterns and molds for casting parts from molten metal, is giving place to the welding shop. There huge machine frames, once bulky castings, now are fabricated from metal "lumber," cut to size and welded together, much as a cabinetmaker would build a fine piece of furniture from wood.

Bridges, ships, railways, pipe lines, automobiles, car wheels [illegible] such smaller useful articles as ladders, tables, chairs, workbenches, wheelbarrows—are being fashioned in remarkable new ways by the welder's fiery needle. Airplanes, too. For example, the plane which carried Lindbergh to Paris employed the welder's handiwork for the framework of the fuselage was made of seamless tubing of chromemolybdenum steel with welded [illegible]

New uses are being discovered daily. The possible applications of this new building science seem almost limitless. Indeed, they bid fair to change the whole face of modern industry. The old popular idea of hustling industry as a thing of infernal noise, belching smokestacks and dirt, gives place to the idea of silent cleanliness. Today manufacturers desire neither smoke nor racket. They recognize both as signs of inefficiency. And they realize that the overwrought nerves of city dwellers are demanding the silencing of industrial noises, just as they now refuse to tolerate the nuisance of cinders and gases.

How electric welding aids even in coal mining. Here a workman is seen with his torch, heated from an electric wire, and his weld metal joining the rail bonds in a mine at Keith, W. Va. The rails help carry the current that moves cars on the electric railway and are joined by metal bonds to make the electric circuit complete. The bonds are effectively made and repaired by the new torch method

IN DEVELOPING methods of silent construction, a number of large electric companies have taken the lead. As told in previous issues of POPULAR SCIENCE MONTHLY, the Westinghouse Electric and Manufacturing Company already has erected four rivetless buildings and it is now constructing a fifth arc-welded building, at Derry, Pa. Similarly, the General Elec-



A two-head automatic arc-welding machine in General Electric works joins metal pieces into 14-foot generator frame and saves casting cost

At the right: A close-up photograph of the inside welding of the stator above showing how the molten metal fuses the parts into one piece

tric Company at Schenectady, N. Y. has announced that its future building programs will call for the substitution of arc-welding for riveting throughout.

In other parts of the country welded buildings recently have appeared. For example, a few weeks ago steel for a new ballroom and tea roof of the Alcazar Hotel in Cleveland, O., was erected without driving a single rivet by using an arc-welding process developed by the Lincoln Electric Company of Cleveland. The work revealed two important advantages: first, welding made it possible to attach the addition to the old building with very little disturbance to existing walls; secondly, guests were undisturbed by noise.

Elimination of noise, however, is only one of many advantages of welding. Practical tests in the laboratories of the U. S. Bureau of Standards and of the Carnegie Institute of Technology have demonstrated that welded joints scientifically made are stronger than riveted ones, indeed, are sometimes stronger than the metal they fasten together. Moreover, welding effects economies in material. Not only does it eliminate steel plates and angles ordinarily required in riveting, but by doing away with the drilling of rivet holes it permits the use of lighter structural members.

THE same economies appear as well in the application of welding to the manufacture of machinery. In the shops of the General Electric Company at Schenectady electric arc-welding recently has revolutionized the making of electrical machines.

Formerly a great deal of time and expense was involved in the casting of the huge frames of generators, which supply electricity for millions of homes and industries throughout the country, were cast in the iron foundry. These machines consist of two main parts—the stator, or stationary part, and the rotor, which rotates within it. For large hydro-electric generators the stator frames often measure forty to sixty feet in diameter. The enormous amount of metal and foundry workmanship has involved a long and expensive series of processes—making wooden patterns, forming molds, pouring molten metal into the molds, cooling, cleaning, heat-treating and machining the castings.

Now, the great frames are built up from a number of pieces, much as a carpenter works with wood. These metal pieces are rolled out and cut to shapes and sizes, then joined by welding—a matter of bringing the parts close together and filling the crack between them with molten steel, which unites with the metal and forms an unbroken joint. The heat for melting the welding metal and fusing the joint is supplied by an electric arc.

IMPORTANT economies in material and labor are claimed for the new method. Machine frames can be made lighter in weight, yet as strong as heavy castings. In making large electrical machines, especially, welding proves a time saver. Virtually all these large machines are "tailor-made"; that is, built to a special design to meet special requirements. When castings were used, this necessitated preparation of special drawings, patterns and often special pits in the foundry. Now standard metal slabs, sheets and bars can be cut and shaped and speedily --

"*I'm* Going to Send *My* Boy to College"

A Plumber Tells from Experience Why He Believes a Diploma Is a Springboard to Bigger Opportunity

By J. B. MINNERLY

NOT so long ago a big-salaried job came sailing into my hands—and I muffed it. Not because I wasn't capable of handling it, but only because I didn't have a college diploma to catch it with.

I'd been doing considerable work for a wealthy man who is interested in several construction and manufacturing companies. I'd installed a large heating system for him, among other jobs. He was impressed by the fact that I knew more about steam installations than his architect did. He saw I was able to write my own specifications and correct technical errors made in the blueprints by a draftsman who should have known better.

Later I gave this business man some expert advice on oil burners and automatic stokers—advice that saved him money and lowered his fire risks. He discovered familiar with electrical control circuits and was thoroughly up on combustion and radiation problems—in fact, could handle about everything in the heating line.

He took me for a technical school graduate and one day he began to tell me about a fine opening for a heating engineer.

"By the way," he interrupted himself, "what was your school?"

"Grammar school and the plumber's trade," I answered.

"We-ell," he said, "I'm afraid this place I had in mind would require a graduate engineer. It needs a man with a thorough scientific background."

Even before he spoke these words, I had realized the thing was all off. The lack of a college degree had cost me other fine opportunities before this. And the worst of it is, my friend was right. I could have handled his job, but a trained engineer could handle it better.

ON MANY practical jobs I can hold my own with college men. I've corrected flaws in domestic heating layouts for which some highly educated expert was responsible. I'm perfectly [illegible] in pounds of steam and tons of [illegible] engineer begins to

hampers a man, these days, at every turn.

And that's why I'm planning to send my boy to college.

A college diploma is a springboard to bigger opportunities—just the diploma itself. And if a fellow has not only the diploma but one half the knowledge of science and the thinking ability he's supposed to have before he gets his diploma, why then he can turn his opportunities into success far greater than the average mechanic can hope for.

From skilled craftsmen I've often heard the remark, "If only I'd had an education, think where I'd be now!"

But did you ever hear a university graduate say, "If only I *hadn't* had an education, think where I'd be now!"

No. College men don't talk that way, because the plain facts are the other way round.

Oh, of course you'll often hear people say some of the things that Mr. Payne did in his "I'm Going to Raise My Boy to Be a Plumber" article, in last month's issue of POPULAR SCIENCE MONTHLY. But they don't really mean what they say. For instance, Mr. Payne suggests that he'd like his boy to learn a trade—unless the boy shows ability for some profession. There's the joker. Everybody knows that business generally is a [illegible] mon, today, and that big business [illegible] re the really good incomes are to [illegible] t.

[illegible] for my part, I think that with [illegible] e prosperity that's ahead of us in [illegible] untry, and with the growing com- [illegible] of big business and the constantly [illegible] ng demands for quick-thinking, [illegible] ssoning executives, there's bound [illegible] rger and larger demand for the [illegible] an. And so I think it's a mistake [illegible] e boys not to go to college, just [illegible] they'll only get $20 a week when [illegible] aduate, to compare with the [illegible] er's possible $66 a week.

[illegible] e it, all discussions like this one [illegible] boiling by superficial thinking [illegible] out that one point of the so- [illegible] lled high wages earned by skilled [illegible] mechanics in certain trades.

All right. Let's look at those [illegible] ges. And let's look at what a [illegible] n does to get them. Outside [illegible] printing and allied industries, [illegible] t of them are paid in the [illegible] ding trades with which I'm [illegible] liar. Talk about a "healthful

outdoor life!" Just try it once. The work is often deadening to the mind, stupefying, physically exhausting—sometimes dangerous.

For instance, take steamfitting and structural ironwork, on which I've seen some fairly recent figures. In 1925, out of eighteen major classes of industry surveyed in eleven states, there was greater accident frequency in steamfitting and supplies and in structural ironwork than there was in any but two other industries.

Anybody who has worked on or watched a construction job knows the risks a man runs, and how they compare with the easy life of a white-collar job. There's many a widow and her small family skimping along on a mother's pension from the state, because her husband was a "highly-paid" plasterer working on a scaffold, or a structural ironworker or a carpenter, instead of an "underpaid" college graduate working at a desk.

DON'T forget, then, that many of the trades are not only a harder and rougher life but a riskier one than what the average college graduate goes into.

And it's all right to theorise about a skilled mechanic being able to earn a good living and meanwhile educate himself to something better. But that isn't so easy as it sounds. A fellow who works all day "on the wall," or struggles with heavy materials and worms his way into cramped corners to wrestle with pipes and wrenches, is just too dog-tired at night to study.

Why, a friend of mine, a mason contractor felt the way I do about college. So his boy Tim went to Cornell—for one year. Then Tim said he'd learned how to study, and he decided to quit college, grow up in his father's footsteps, and continue to educate himself while he earned $8 a day as a helper.

A short time ago Tim's father asked the boy why he wasn't spending more time with his books.

"Dad," said Tim, "after I've worked all day and get home to supper, I'm ready to hit the hay. My body's so tired that my mind won't work."

Besides, there's nothing in the life of an apprentice that will stimulate him to keep on with self-education. The influences are all the other way. The other fellows sneer at intellectual interests. The boy is discouraged from books and study and thinking. He's apt to fall into rough habits and rough language or else be an outsider. Everything tends to narrow his point of view.

But a college boy at the same age is stimulated on every hand to broaden his mind and pick up not only knowledge, but the polish that will make him successful in meeting big men.

No—there's nothing in that argument about being able to live high on a mechanic's income and meanwhile educate yourself. I'm self-educated, and I don't think I've done a bad job. But nobody who hasn't gone through it knows what wasted effort and mistakes and heartbreaking toil go into a self-guided education. I've picked mine up without help, at odd moments, with out-of-date text books from the library. I've studied until late at night when I had a hard day's job behind and another ahead. I don't begrudge the toil—but so much of it was inefficient and fruitless! Educating yourself is like trying to fly across the Atlantic without a compass.

And now for those "high wages" which are supposed to compensate the skilled craftsman for the hardships, risks or limitations of his life.

"Why," says Mr. Business Man playing golf with his friend, "do you know what plumbers are getting in my town? Twelve dollars a day! Plasterers are getting fourteen dollars! Think of it! For doing something I could learn to do in six weeks!"

I'm not so sure Mr. Business Man could learn as fast as he thinks. And I'm sure he wouldn't stick to it very long after he had learned. It's not the same pleasant exercise that Saturday golf is.

But even if he did stick to plastering, say, for a whole year—what would his income be?

I suppose he figures fifty-two weeks in a year at $14 a day. That would be about $3,900 a year, as he dopes it out. Well, $3,900 a year isn't so bad, although the figures used in Mr. Payne's article show that a technically trained college graduate on the average reaches $4,000 when he's thirty-two years old, and keeps on going up to $7,500 when he's fifty-two. But the average plasterer's wage—even at Mr. Business Man's guess—doesn't reach $4,000 at the age of thirty-two, and by the time the plasterer is fifty-two his pay is more likely to be diminishing instead of increasing.

However, there's a still bigger flaw in the argument.

If we're going to compare national averages, and college graduates with skilled workers, it isn't fair to take the exceptional wages of a few trades in large cities.

Take the skilled trades generally for the whole country, and we find from Government figures that the average rate of wages in 1925 for fourteen of the better paid crafts was $10.24 a day.

WHICH means that the skilled laborer's income—assuming he works five and a half days a week throughout the year—is only $2,840 instead of $3,900. But he doesn't work the full fifty-two weeks. He doesn't get a vacation on pay the way the white-collar worker does. Legal holidays are lost time. If he's sick, or if the weather is bad, his job stops. So, to square up our comparison with the white-collar man's salary, let's deduct the two weeks vacation and the holidays, and we find our "highly paid" mechanic is getting only about $2,100 a year to compare with the college graduate's $4,000.

The other day I saw a table showing that the *starting* salary of 245 Harvard graduates in 1926 averaged $2,000—which is almost as much as the average mechanic can hope for year after year throughout his working life.

And that doesn't take sickness into account, or lost time due to trade conditions. It's said that on the average, in normal periods, lost time in the building trades will amount to about one third of a year. I've looked up the most reliable figures I can find, and they show that lost time in the building trades for 1925 was equivalent to a year's idleness for 12.3 percent of all workers engaged.

All of which seems to me to puncture

Mr. Business Man's theory that a plumber or carpenter earns about $66 a week for fifty-two weeks.

Besides, the mechanics in the building trades aren't the only skilled workers. If we're going to take college graduates as a class and compare them with skilled labor as a class, we've got to go beyond the construction industry. A recent report of the National Industrial Conference Board covering twenty-six great American industries shows that the average hourly earnings for skilled male workers are 65 cents—which comes to $5.20 for an eight-hour day instead of the $10 or $12 a day earned by certain groups.

NOW if Mr. Payne is going to li his argument to the most fa groups, and declare that a boy ou be raised for a plumber so he ca $12 a day, then I can say with fairness that I'm going to send my boy to college so he can be a consulting engineer at $30,000 a year — which is a figure some engineers reach and which no plumber ever reached as a plumber.

And that brings me to the big point on the financial side of this discussion: the much larger financial opportunities available to the college man.

I want to make clear, first, however, that I'm not spreading any hard luck story on behalf of the manual worker. Skilled labor is getting reasonably good money in this country. Many workers can live well, drive a car and have leisure and pleasures. I think most men get about what they're worth, and haven't got any kick coming.

Indeed, that's the nut of the whole thing. The mechanic's wage fairly measures what he's worth, and he's never worth any more because he hasn't got the c education that helps a man make h worth more and more as he grows

Once a bricklayer, always a bric There aren't so many chances to be foreman. One foreman can gang of as many as twenty bric There are fewer chances still to b superintendent. A chart of the Industrial Conference Board sho superintendents and foremen, together with the owners of sm lishments and with their sales engineers, constitute all told percent of all persons engaged i ical and manufacturing industri

That gives you a fair notion — how much chance my son, as a plumber, would have to grow up through foreman and superintendent to a business of his own.

But as a college graduate he'll be a brain worker, and won't have to stick to just one routine that he's acquired a knack for. He'll be able to sense any big chance that comes his way. Figures on the graduates of four well-known engineering schools—Lawrence Scientific, Lehigh, Stevens Institute and Towne Scientific—show that between fifty and seventy percent of the graduates, twenty-five years after graduation, are engaged in some pursuit other than engineering. You see, those fellows have been able to branch out. Because they had trained minds they were able to grasp new activities. Not so the plumber. He must go on wiping joints to the end of his days, because such tricks of his trade are all that he knows.

The college educated brain worker may still be going good, well after sixty. But the skilled manual worker has begun to lose his grip before that. I know of men in the building trades who at the age of sixty are having to work as helpers to their own boys!

And talk about a plumber going into — it isn't lack of ability, always— just lack of the education that would start them off on the right foot.

So that's why I want to send my boy to college. Not to learn Greek or history or science—but to *learn how to learn.*

In a booklet written by Vice President Reeve Schley, of the Chase National Bank of New York, I find a statement that sums up this point very well. Mr. Schley says:

"The principal benefit of a college education is not what one learns in college but the knowledge one obtains of what can be learned in future years. This is the greatest advantage which the college trained man has over the man who has not had the same kind of education."

The practical mechanic knows very well that the science and theory which he hasn't got are more important than the rule-of-thumb details that he has got. When I took up heating and steamfitting I found I had to learn the theory. When I went into sheet metal work I had to discover for myself that there was such a thing as geometry—and then I had to teach it to myself, which wasn't easy.

If my son is to be where I hope to see him—either running his own business or a salaried executive in somebody else's —why, he's got to have a thorough grounding in theories and principles. He's got to be up on economics, science and history. I've been reading up on this subject, and I find that the opinion is very general among big business men that the college man soon becomes more useful to them than the other man, just because he has both this sort of knowledge and the knowledge of how to find out what he doesn't know.

THE result is that he soon leaves the noncollege man behind. Data published by the Bureau of Education shows that ninety percent of college men are successful in rising to against 25 per- ge men. An in- the careers of large factories, ars ago by James rmer President of Society of Me- neers, brought out age of thirty-two of trade schools highest earnings, ly fifty-eight per- rnings of technical ates; and that the apprenticeship ex- r maximum at the is maximum being ent of the earnings e graduate.

understand that it man on the average o reach the higher the college man only in the railroad supply n told is fairly repre- nufacturing generally, of the higher executive by college graduates, and it took these graduates ten years less than the noncollege men to get there.

Figures from a typical big public utility show a similar advantage for the college man—eight to ten years saved in reaching the executive level. I've seen it stated that a survey of the entire supervisory force of the Westinghouse Electric and Manufacturing Company showed approximately fifty percent of the men in these responsible positions were college-bred.

Now the census tells us there are about 33,000,000 men in this country working for pay. All living male college graduates constitute only about nine tenths of one percent of this

(Continued on page 160)

Hunting Wild Zebras *with* Fishpoles

The Story of a Thrilling Round-Up of Striped Beauties for the Zoo

By THOMAS W. PHELPS

Hooked! A lariat about his neck, struggling zebra is tied to his captor's horse

"KEER! Keer!" shouted the other zebra hunters to us, meaning "stop him!" Towards us, up the hill, raced a magnificent zebra. Jerry Bouwer, fleetest of the riders, galloped after him, carrying a bamboo fishpole, tipped with a noose of rawhide.

Bouwer, leaning far forward, held the noose almost over the zebra's back. Then his horse fell into a hidden ditch. Bouwer did a short flight, made a perfect three-point landing, and bounced to his feet.

That was my introduction to the South African method of "fishing for zebras" with all its speed and thrills.

In the bush-covered valley of the Little Karroo, twenty miles south of Oudtshoorn in Cape Colony, I encountered seven horsemen carrying fishpoles, who told me they were out to catch wild zebras. Special permission had been given by the administrator of Cape Province, they said, to catch the rare mountain zebras, alive, for European zoos. They needed another man. I joined them.

Three of the riders started off across the valley toward the left, and three more to the right. The two poorest riders—I was one of them—remained to mount the top of a *kopje* between the scouting bands and act as lookouts and reserves.

Our plan was to circle the base of the hills without disturbing the zebras. Their retreat to the mountains cut off, we could drive them toward the plain and run them in circles until near enough to drop nooses over their heads. Each of us carried the curious fishpole, with its rawhide lariat.

From the top of our hill we watched the other horsemen, immersed up to their mounts' bellies in a sea of bush, until they were mere specks bobbing in the distance.

"Landing" a frisky zebra colt with rod and line. It's a thrilling game whose object is to capture the rare animals unharmed for zoos

A sudden outcry brought us to our feet. We saw a zebra scudding across a barren stretch of ground just below us. Three horsemen were after him, riding like mad. "Keer! Keer!" they shouted, as Bouwer spurred forward and then catapulted to earth from his stumbling horse.

That didn't stop Bouwer. Bounding to his feet, he kept on running. For twenty yards, it seemed, he actually held his own with the surprised zebra. It darted up the hill toward us.

With much shouting and waving of arms, we turned the animal back. Bouwer, helping his horse out of the ditch, rejoined the chase, in which we now entered. To save our horses we tried chasing our quarry by turns.

Surefooted as a mountain goat, he seemed to delight in the worst going, taking us through wiry brush and flood washed ditches. A dozen times we could have ended it all by driving the zebra into a fence corner down the plain, but the hunter had specified that the animals must be delivered alive and uninjured. Bouwer knew that recently another hunter had caught four of the rare animals in a *kraal* only to see them dash themselves against the walls.

NOW Bouwer's horse was tired—but so was the zebra. A final spurt, and with his fishpole Bouwer dropped the noose over the zebra's head. It tightened. The zebra reared frantically on his hind legs, then bit his captor. Luckily his teeth caught only a piece of flapping trouser leg. He was at once roped to the horse. We drove and dragged him back to camp.

I was fascinated by the novel scheme of "zebra-fishing." "What's the matter with lassoing the zebras?" I asked.

"The zebra is too smart and the ground too bushy," my companions explained. "We imported an American cowboy to try it. We drove a zebra past him eleven times and no matter how hard he tried he couldn't catch it. He couldn't lasso the zebra's legs because of the tall bush. When he tried for the animal's neck, the zebra put its head between its legs or dodged the rope altogether.

But with a fishpole Jerry Bouwer alone has started more than thirty of these wild little animals on zoo and circus careers in various parts of the world.

Three "fishermen on horseback" carrying bamboo poles and rawhide lines, ride across the bush-covered South African valley toward the mountain retreats of the zebras

Solving World's Mysteries

Advancements and achievements in various scientific fields of research and invention, important because of their bearing on the daily interests of life, are recorded monthly on these pages.

Volcanic Island Alters Its Face

ONE of the strangest new discoveries is that of a changeable island which alters its face from year to year. It is Bogoslof Island, owned by Uncle Sam, one of the Aleutian group southwest of Alaska. Dr. T. A. Jaggar, volcano expert, who has been studying these islands for the United States Geological Survey, recently reported that Bogoslof has changed entirely since he last visited it twenty years ago. Among its new features are a lava peak 200 feet high, a lagoon of warm water, heated by volcanic fires, and alteration of former island peaks.

The strange place has been called "the Lost Chain among islands." Its only inhabitants are hundreds of sea lions and thousands of birds, the latter apparently attracted by the volcanic warmth.

Since the volcanos there continue active, Dr. Jaggar believes the island will keep on changing.

Engines Run on Fish Oil

EXPERIMENTS in extracting oil from soil at the bottom of the ocean were described on these pages in the October POPULAR SCIENCE MONTHLY. Now two French engineers, Georges Lumet and Henri Marcelet, claim success in using oil from fishes to run Diesel engines, which ordinarily use petroleum. The heating value of fish oil, they found, was not greatly inferior to that of mineral oils, nor was its burning accompanied by bad odors, as had been expected. The fishy smell of the oil evidently was destroyed by combustion.

When Diesel engines are made in small enough sizes to be used in automobiles—a likely development—the teeming life of the sea may become an important source of motor fuel supply.

New Aluminum Rival

IN THE manufacture of machines and household utensils aluminum soon will have a remarkable rival. The new metal called beryllium, extracted from ores previously dumped away as waste, promises special value in making frames for airships and pistons for automobiles.

Photographic evidence that convicts the fly of spreading disease is obtained by F. Perry South, London, with an apparatus by which he photographs and magnifies fly footprints. At left, a fly's tracks just made. At right, the same tracks twelve hours later showing how the germs from decaying matter left by the insect's feet have developed. Soon they will become spores to be carried away by rain or other flies

Beryllium is about a third lighter than aluminum, yet much harder. H. S. Cooper, industrial chemist of Cleveland, Ohio, has found in experiments that its elasticity is four times that of aluminum and twenty-five percent more than that of steel. It resists salt water, which corrodes aluminum, and seems impervious to liquids and fumes that destroy most metals. Light gray in color, it takes a polish like that of fine steel.

An alloy of seventy percent beryllium and thirty percent aluminum is one fifth lighter than aluminum, yet far stronger than duralumin, the lightweight metal now used widely in airship construction.

Beryllium ores, hauled out of feldspar mines in New England by hundreds of tons, have been thrown away as waste. The commonest type is known as beryl, sometimes worn as a semiprecious stone.

Antitoxin Victor Over Erysipelas

IN THE everlasting battle for the relief of suffering, possibly the most important mark of progress during the month is the announcement that erysipelas soon will be added to the list of vanquished diseases. At Bellevue Hospital in New York Doctors Douglas Symmers and Kenneth M. Lewis have met surprising success in the use of an antitoxin for this painful inflammation of the skin. Mortality from the disease has been reduced one half—from ten to five percent. The antitoxin was developed by Dr. K. E. Birkhaug, of Rochester.

"This treatment," reports Dr. Symmers, "marks an advance, the results of which are commensurate with those obtained in the treatment of diphtheria."

In experiments to combat hardening of the arteries, Dr. Hans Guggenheimer, of Berlin, has discovered that very small doses of iodine apparently help quicken blood circulation.

A possible remedy for nearsightedness has been found by Dr. Meyer Wiener, of St. Louis, in the administration of epinephrin, the powerful drug that is extracted from the suprarenal glands.

Further tests of the curative value of the cathode rays from the tube invented by Dr. W. D. Coolidge of the General Electric Company have revealed that exposure of various substances to the rays gives them the power to prevent and cure rickets. Among such substances are brewers' yeast, cornstarch and cottonseed oil. Yeast exposed to the rays for thirty seconds was found ten to twenty times as powerful in its curative effects as cod liver oil.

While others listen in, Fred J. Shaughnessy, of Rochester, N. Y., a deaf mute since childhood, "feels in" for evening concerts with a diminutive disk-shaped cone speaker which he devised for his set. He says that the vibrations he feels are music to his sensitive fingers

Motor Car Advance

NEW processes of manufacturing automobile crank shafts that will make new motor cars much easier to break in, prevent wear and reduce oil dilution, were recently described to the Society of Automotive Engineers. Instead of being ground and polished with emery, the crank shafts are by the new method honed like a razor with abrasive stones to make them smooth and true. The honing permits smaller clearances in the bearings, thus materially reducing vibration and wear

Fish Oil Motor Fuel—Newest Metal Surpasses Aluminum—Music Of Earthquakes Is Studied Other Scientific Advances of Month

Tiniest Particle May Be Etheron

ARE the electron and its consort, the proton, after all, the ultimate tiniest units of matter? If not, then what is the smallest thing in the universe?

Sir J. J. Thompson, noted British physicist, recently declared his belief that even these ultra-tenuous electrified particles are divisible into still simpler pieces to be revealed by further study. Present theory holds that every atom of matter is composed of one or more protons, around which revolve one or more electrons. The atom itself is so small that it takes seven figures in fractions to measure it. The electron is 1800 times as small as an atom, and the proton even tinier. Yet even these, Thompson declares, are insufficient to explain all of the atom's behavior.

An answer may be found in the remarkable theory just advanced by Capt. T. J. J. See, U. S. N., mathematician and astronomer. From studies of gravitation, he concludes that the smallest thing is an ultra-tenuous particle of ether called the etheron. So fine are these ether particles that they freely penetrate the earth.

"If atoms of common gas such as hydrogen, nitrogen or oxygen be magnified the size of lemons, oranges or grapefruit," See explains, "then on this same scale the electron is like a coarse grain of sand, and the etheron is like a fine particle of smoke from a cigar."

Limits Seen for Television

WITH the marvel of television achieved, many of us have believed that soon we shall sit by our firesides and view distant events as they happen, but experts now express doubt that this dream will ever be realized.

Enormous obstacles, they say, still stand in the way of practical television for everybody. Chief of these is the speed difficulty. The best television apparatus developed by the Bell Telephone Laboratories is able to transmit a clear action picture only about three inches square—far too small a space, engineers say, to portray a football game or a king's coronation. Yet even this requires the transmission of 40,000 dots of light and shadow every second to produce a true effect of motion—sixteen different scenes a second, each containing 2500 dots. Moreover, such a picture now requires elaborate apparatus that would fill a room.

To produce a picture four times larger, engineers say, would require the sending of a hundred thousand separate impulses a second, each reproducing a tiny spot of light or darkness. Such enormous speeds, they fear, may never be attained.

A rubber-sulphur compound, believed superior to gutta-percha for ocean cable insulation, is under test by A. H. Scott, a U. S. Bureau of Standards physicist. Placed in iron pipes, it is subjected to 10,000 pounds pressure to the inch. The instruments measure its performance as a nonconductor

Rain Making Yet Unachieved

POSSIBILITIES of artificial rain making are remote, says Charles Maurain, French meteorologist, in a recent summary of present knowledge on this fascinating question. Only when the atmosphere is already supersaturated with moisture—a rare occurrence—could rain be made, he says, unless some way could be found to agitate the raindrops of a cloud and make them combine into bigger drops that would fall.

Such experiments, conducted by J. Violle with small-scale explosions, have almost without exception proved fruitless. The mighty blasts set off not long ago in France in other experiments caused only occasional formation of clouds.

In a poison gas chamber in London gas masks and other life-saving devices for firemen, miners and soldiers are tested for efficiency. Here a subject inhales pure air from a tank and exhales it into the arrangement of tubes in which it is examined. Later he will inhale gas-laden air through a mask and exhale it into similar tubes. This will be examined and compared with the pure air that was free from gas. Impurities in the exhaled air are identified by their effects on chemicals in the glass tubes and on pure oxygen which is later found with it

Tides of Blood Present Problem

DAILY tides in blood pressure, heartbeat and other functions of the human body, almost as regular as the tides of the sea, may be caused by mysterious forces beyond the earth, as are the ocean tides. Such is the recent statement of Dr. P. E. Morhardt, French physiologist, who suggests that they may be produced by daily variations in electrification of the air.

It is well known to physicians, Dr. Morhardt points out, that the temperature of the body rises slowly in the forenoon and reaches its height at about four or five o'clock in the afternoon. During the evening it recedes, reaching "low tide" in the early morning. Similar high and low tides at about the same hours are found also in the human pulse rate, in the amount of oxygen used in breathing, and in blood pressure. A strange fact is that the flow of the tides in persons who work at night is no different from that of persons who are active during the day. That zoologist is not responsible is evidenced by the fact, according to Dr. Morhardt, that in northern countries like Iceland, where there is a season when the sun never sets, the same rhythm of bodily tides persists. Either mankind has daily tides in body functions, or some external cause is affecting us all in the same way.

Earthquakes to Order Next?

A NOVEL way of exploring the mysteries inside the earth recently was suggested by Doctor R. B. Sosman, of the Geophysical Laboratory, Washington, D. C. He proposes to produce artificial earthquakes by setting off small explosions, somewhat as has been done in France, or by dropping heavy weights on the ground. By measuring the speed and intensity of waves thus produced in the rocks, he believes it will be possible to determine the earth's interior structure.

New studies of earth movements by Paul Kirkpatrick have led to the curious suggestion that the destructiveness of an earthquake may be determined by the "music" it produces—that is, by the pitch of its vibrations, corresponding to the pitch of a musical note. In most quakes, he points out, the earth vibrates back and forth many times, like a piano string. Just as the deep bass notes of an organ will shake the windows of a church, while high treble notes have little effect, so a slow low-pitched earthquake may knock down more buildings than a high-pitched one that vibrates rapidly.

Whirling Wheels

By

EDMUND M. LITTELL

Illustrated by B. J. Rosenmeyer

The world was reeling. Gil struggled to his feet. "Where's Wally?" . . . Over there men were running toward a motionless bundle of something. Wally

A Novel of the Automobile Age In This Installment, the Most Thrilling Race Story You Ever Have Read

IN THE great Game of Speed, as in the Game of Love, Gil Herrick and big Jim Wenden were bitter rivals. The feud dated back to the early days of the automobile when Gil, a young mechanic, and Jim, the town bully, raced their crude motor-wagons over Michigan country roads, and vied for the hand of a beautiful girl, Gail Caswell. It grew when the two matched their wits later in the gruelling competition of automobile manufacture.

Emerging victor in the Game of Love, Gil found himself engaged in a desperate struggle for survival against his powerful adversary in the Speed Game. In the development of the automobile, both men had attained positions of influence—Jim, by financial manipulations that were often shady; Gil, by long hours of discouraging labor in developing his own mechanical ideas. Through disappointment and adversity Gil was saved from ruin only by his own dogged grit, and by the loyalty of men who rallied behind him—Mac, the chunky Scotch foreman; Wally Burns, the tow-headed machinist; Andrews and Morton, the salesmen, and Oliver H. Marston, the banker whose financial aid he had won.

Jim, thwarted in his attempts to destroy him, challenged Gil to settle the question of speed at the coming Vanderbilt Cup races, at the same time flinging the drunken boast that at last he had "got" his old rival. Now read on:

THERE followed months during which Gil's attention was directed to one thing—the construction of a racer. No one knew how much that machine cost. He had a private account set up for it, and kept it to himself. And what a car that was!

Two years before, the Herrick plant had begun to use drop forgings wherever possible. Spring shackles, connecting rods, valves, gears—there was one transmission set that had four gears forged integral with the shaft, a roll forging; even the little bell cranks that were parts of the throttle and spark connections were drop-forged. Phosphor-bronze castings had been all right when the quantities ordered were small, patterns cost considerably less than the great dies that had to be cut in steel blocks for use in huge drop hammers. But now Gil was using drop forgings—and going to even greater expense. He was using the new alloy steel on the racer.

Alloy steel as such was not new. A great deal of nickel steel, from one to five percent, was manufactured and used, for gears, mostly. There was even some tonnage of Krupp steel—chrome-nickel analysis—imported from Germany. But the new steel, chrome vanadium, had not been used before in America.

One small mill had had the courage to undertake its manufacture, and was doing it right, though progress was slow. It required special care for special steel, with specially trained men to introduce it. It involved too many additional costs for ordinary shop equipment to handle it. Heat treating furnaces had to be installed, pyrometers, quenching tanks; the greatest care had to be exercised in all its heating. Shops were reluctant to undertake it, but not Gil Herrick. He saw the double, triple, even quadruple strength that could be attained, the toughness that was almost unbelievable. The stuff just wouldn't crystallize and break, and Wally Burns in the service department knew

how much trouble that would save.

That was the steel Gil Herrick used, with furnaces, tanks, electric thermocouple thermometers and all. He made springs, gears, crank shaft, even connecting rods out of that steel, and followed the suggestion of a mill man as to what carbon content to put in the various places—ninety carbon in the springs, fifty-five in the gears, forty in the shaft and rods. He hollow-bored the crank shaft and rods to reduce weights. And he put on extra brakes.

ALREADY he had increased the braking capacity, with drums on the rear wheels besides the old transmission brake; now he enlarged the faces of his drums and installed a new woven asbestos lining. He even discussed the idea of putting drums on the front wheels, but gave it up as unnecessary. To reduce weight a little more, he made the transmission and crank cases of aluminum instead of cast iron, and hollow-bored the drive shaft. All to beat Jim Wenden.

Winter melted into spring, spring warmed into summer, and a racer began to roar along the roads out Mount Clemens way, with Gil at the wheel and Wally Burns beside him. Squatted low in the bucket seats, with the steering wheel so raked that it was in Gil's lap, and Wally with a hand pump which brought oil from the tank behind and forced it into the engine. Some of Jim's men clocked a mile in forty-five seconds once, but that was all they could get. And Gil—he made no slightest effort to find out what Jim was doing. Until it was too late.

Oh, Jim had a racer, all right. It was running the roads out Dearborn way, for his factory was on the other side of town. And he was driving it, too. But that wasn't the thing Jim was most interested in, it developed. He disappeared from town for a couple of days, and came back with a grin on his face and a devilish twinkle in his eye, but said nothing except, "Still driving, is he?"

Gil was. And paying little attention to anything else those days. The lure of speed is an insidious thing, it gets into the blood like wine; so that he failed to see what was going on in the rest of the world. They all told him. Bob Legg said money was getting tight; Andrews and Morton said the car wasn't selling as fast as it should. Wally Burns had an indicator in his department—they were not shipping out as many spare parts as usual, which meant that machines weren't being used. And Oliver H. Marston

"Gil, my boy, we're in for mighty hard times. Better climb out of that racer of yours and take a few reefs in your sails."

There was so much of earnestness in those words, and they came from such an authority, that Gil turned away from the drug of speed and bent his attention to balance sheets, sales reports, and liabilities. Too late.

DEALERS weren't remitting as they should. Cars were in their hands, and when pressed for settlement they all said they could not sell cars, so they had no money. All over the land bankers were growling. "Too much money going into these luxuries; too many automobiles. People can't go on mortgaging their homes to buy them; it must stop." Hence mortgages were a drug on the market, and people with ready money were frightened at the clouds on the financial horizon, and hanging on to what they had. Panic was in the air.

But even so, Gil laughed. "What is a panic?" said he. "A state of mind, that's all. Everybody thinks hard times—and that's what we get. This business is not dead, the automobile is not a luxury. We'll go on. No matter what the bankers say—with apologies to you, Mr. Marston."

And that worthy gentleman shook his head. When it came to banking he was a banker, not a friend. He had some stock in the Herrick outfit, and he was hanging on to it, but . . .

Gil hastened to do the honors opening the door and standing aside. "Glad you came, Jim. Come again," he said. "See you at the Vanderbilt Cup

"Whether we are right or not, there is a scarcity of money that is growing worse. We're in for mighty hard times. I hope you can save yourself, but there are many automobile companies . . ."

"That would go on the rocks anyhow," interrupted Gil. "But we'll pull out. Just because Jim Wenden would get a laugh if we didn't."

That was the mood when their annual stockholders' meeting took place, with gloom ridden men sitting about the long directors' table in Gil Herrick's spacious office. Even Gil felt the depressed morale of those men and experienced a little of it himself. His treasurer, Morton, had a miserable statement; his sales manager, Andrews, a worse one; Mr. Marston's face was almost haggard, for a big New York bank had just failed and he was in desperate straits along with every other banker—and big Jim Wenden walked in!

GIL jumped to his feet. "What are you doing here?"

"Attendin' a stockholders' meeting," grinned Jim.

"By what authority?"

"The same kind you had at the A. L. A. M.," said Jim with a "what-do-you-think?" sort of an air. "Stock, bought and paid for, with cash money. got any in your bank, Gil?—an' a few lovely proxies. I collected 'em while you were gettin' ready for a race."

He tossed a thin bundle of slips on the polished table, and Gil picked them up. So *that* was why Jim had teased him into a race! Gil's good friends in Wendenville had been persuaded to sign their stock over, the ones who had stood by him so staunchly in those earlier days.

"All but your father's, I see. You didn't dare to talk to him about it, did you?"

Jim shrugged. "Well, there's enough," said he. "They agreed with me, you were spendin' a little too much time an' money on racers an' such. They haven't had such an awful lot of return on their investment, an' they agreed with me it might be well to have a capable receiver—excuse me, gentlemen. Perhaps I better wait until our worthy president calls this meetin' to order before I get busy."

If ever a man's mind was chain lightning in a pinch, Gil's was during the next few minutes. Several heads around that table, too, began to take serious thought. Four of those heads

bent over pads of paper that were placed before each seat. four hands extracted fountain pens and wrote busily. It was not until afterward that they showed what they had written to Gil, each written slip was a resignation, to take effect immediately. They were signed by Macintosh, Legg, Andrews and Morton, each of whom had a number of shares that was much too small to be of use in such an emergency. The meeting having been put in session, Gil's plan was laid. He turned to the secretary who was ready to take notes.

"Miss Foster," he said, and there was a light in his eyes that promised something besides surrender, "will you be good enough to take this key—" handing her one which he selected from a ring—"and get the envelope that is marked 'Emergency' that is in my private drawer?"

Miss Foster—she was the same light haired lady of uncertain age who had been his original office force—took the key and started to leave the room

"Wait a minute," growled Jim. "You're delayin' this meeting."

"Maybe you'd like to run that errand yourself, Jim," Gil suggested with a grin, "but it can't be done. There's only one person here who knows just where that drawer is. Miss Foster—"

SHE left, and Gil leaned back in his chair with the grin still in evidence. He was the only one of them all who appeared to be at ease.

"How's the racer coming, Jim?"

Some sort of mutter, that was all

"Still got enough money to buy a set of tires for it?"

No answer.

"Well, ours seems to be able to cover the roads fairly well—ah, here's Miss Foster. Thank you."

He took the bulky white envelope that she handed him and hefted it absent-mindedly, as one would test the feel of a baseball bat—or a club.

"Now," he said—to Jim Wenden and no one else—"this meeting is ready to discuss any matters that may come up. I suppose we'll have to have the minutes of the last meeting read before we can continue." They were read and approved. "And the treasurer's report. This should be very interesting to you, Jim, make you feel at home."

It was an abnormal thing, that report, and Jim laughed when it had been finished and approved, then called for the floor. But before recognizing him, Gil made a little speech.

"Gentlemen, in so far as dollars and cents, assets and liabilities are concerned, this company appears to be insolvent. But it has something that very few organizations have—" with a sharp glance at a frowning Jim. "It has the loyalty and devotion of some of the finest men this game has developed, and not a few of them are sitting around this table. This company will pull through. There would be no need for me to mention that fact if it were not for our unexpected guest. Now—" his hand fell as if by chance on that bulky envelope—"there are other things this company has. Well—not this company—to be exact—myself. But what I have belongs to this company. I have been accused of failure to tend to my knitting," with a glance at the worried Mr. Morrison. "I have no doubt been accused of many other things—such as throwing in a pair of suspenders. But I have not been asleep, gentlemen, nor is building a racer the only thing I've done."

He stopped, and looked into each face. He got a grin from some of them, too, for they had a hunch by this time that something good was coming. There was an assurance about G. W.; a definite purpose was written on his lean face. It was as legible as the two sharp lines that creased his cheeks. Something was about to break. They listened expectantly as he talked.

"Did you ever play with dominoes, stand them up on end close together?" He illustrated with the envelope, holding it upright on the table. "And then did you ever push the end one? What happened?" Plop! the envelope fell flat with a sound that almost made them jump. He was looking directly at Jim Wenden as he did it, and Jim's gaze dropped to that envelope. "No need to answer; it's a foolish question. But it illustrates something. If this company topples, within twenty-four hours another one—and who knows how many besides?—will go down with it. I have papers here—Mr. Legg there will bear me out—that will set in motion certain legal proceedings—pardon me; I'm talking too much. Mr. Wenden, you have the floor."

"You haven't told me what's in that envelope."

"Nor do I intend to. It is marked 'Emergency' and like a fire hose it's for use—not conversation. What was it you wanted to say?"

For a long minute Jim Wenden stood there in silence. "Seemed like a week to me," said Andrews afterward. "But when I saw him begin to crumple—" Which is exactly what Jim Wenden did. In little, tiny ways. His eyes wavered, the grin that had been on his face faded, the jaw line seemed to soften, and the out-thrust chin pulled back. Little signs, underscored by what he said: "I'll listen—and Jim sat down.

Here was where they expected Gil to laugh, but he did nothing of the sort. Instead, with that envelope turning over and over in his hands, he glanced about the table. "Is there any other business to come before this meeting?"

And red headed Andrews covered himself with glory. No one else thought of it at the time; they were all thinking that the meeting must be adjourned while there was a chance. But he got to his feet and added what might be termed an insult to injury.

"Mr. President," and Gil bowed silently. "There seems to be nothing of importance sufficient to deserve this body's further consideration. But before I put my motion I want to express, for those gathered about this table and all those stockholders who are unfortunately not able to attend, the feeling of confidence in our president that I am sure everyone has. (Cries of "Hear! Hear!" from all of them—except Jim.) Every stockholder in this company has implicit faith in the ability of our president to steer the company through this time, and the best method of expressing such faith is to make a motion for adjournment with that understanding. I therefore so move."

"There honey, I won't race any more, . . . If I only listened!" Tears rose in his eyes

EVERY man there seconded it, and the motion was carried without a dissenting vote, for Jim had got up with a sickly smile on his face and was walking toward the door. Gil hastened to do the honors, opening it and standing aside.

"Glad you came, Jim. Come again. See you at the Vanderbilt Cup." And after he had closed the door upon a broad back he made a little saluting gesture with his hand. "You're welcome to the T-head motor," he added.

"What the Sam Hill did you have in that envelope?" cried Andrews, then, and Gil walked back to the table and opened it, while the whole bunch gathered round. There were a few stock certificates of the Wenden Motor Car endorsed in blank, but that was all. There were no legal documents whatsoever.

"If you'd asked me what I made out, I'd ha' been stumped," laughed Legg.

"But I didn't ask you," grinned Gil. "No, what I had in there was a man's conscience," he went on. "Jim hasn't been playing fair, and he didn't know I knew it. He also failed to ask me to prove anything on him—which I counted on. He has been using company funds on the Q. T. to buy control of some other companies. More trust stuff, see? (Continued on page 153)

Aviation *Needs 10,000* Young Men

Flying Only a Step Toward Better Places as Designers, Engineers and Transport Chiefs

By CALEB JOHNSON

WANTED: Ten thousand young men to qualify for positions in aerial transportation service.

THAT'S a want ad which hasn't been printed; but it sums up the needs of commercial aviation in America.

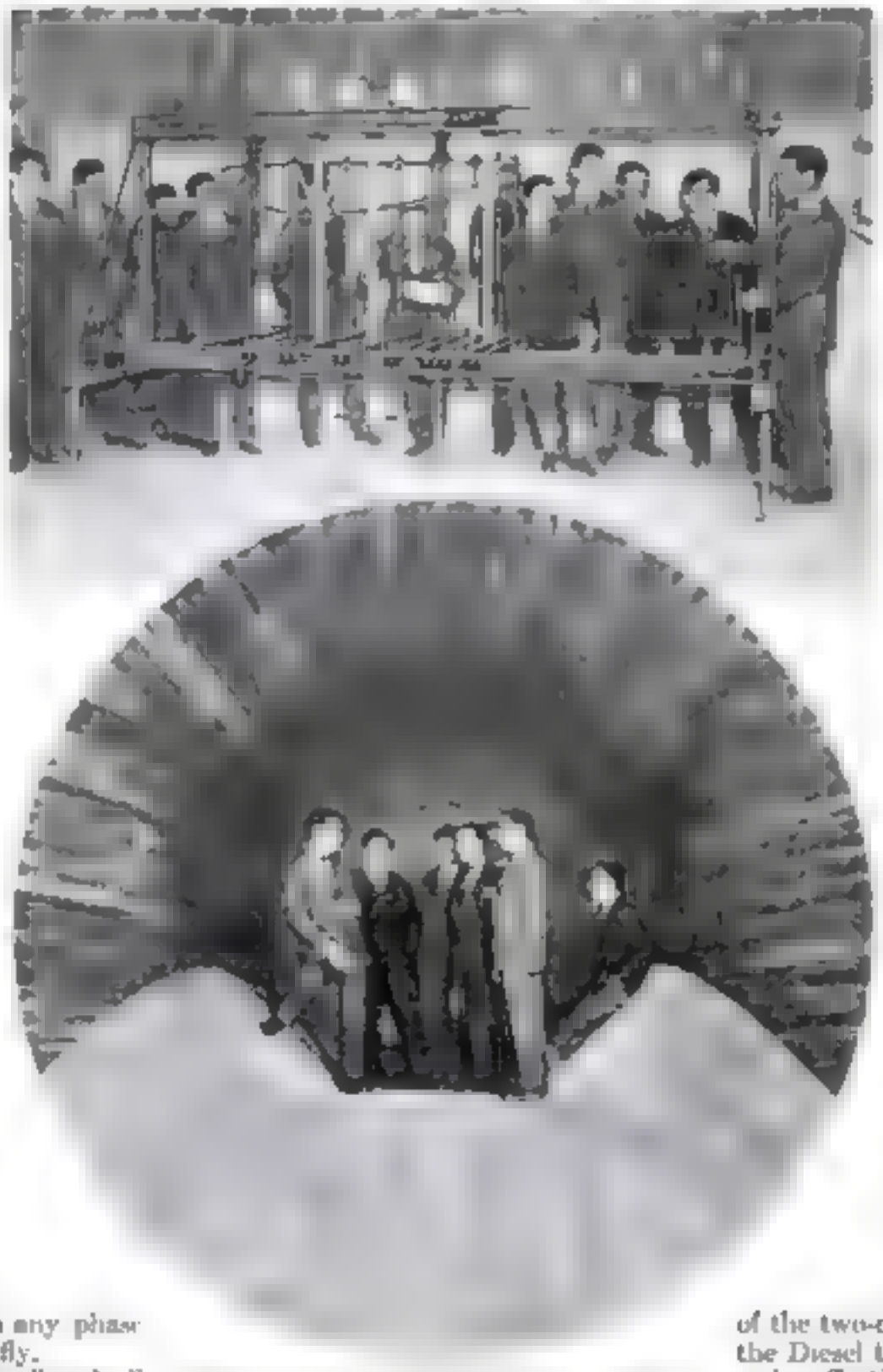
Now, don't crowd, young fellows. There's plenty of time. Nobody has ten thousand jobs waiting to be filled yet. Read that ad again. It says "to *qualify* for positions."

There are a few jobs ready now—for the men who can find them. That means men who have unusual initiative, vision and enthusiasm. For the specially qualified man in certain branches of the science and art of aviation there are other definite needs. But if the public interest in commercial aviation continues to grow, there will be a big demand for qualified men a year from now and in five years the ten thousand young men who will begin to qualify now will come into their own. It will take them from one to five years to qualify, and the jobs will be ready by the time they are.

That is what all the airplane designers and engineers and operators of air services I have talked with agreed upon. All put the emphasis on something besides flying, but all said that everybody having to do with any phase of aviation ought to learn to fly.

"They all want to be Lindberghs," said Frank Russell, vice-president of the Curtiss Aeroplane and Manufacturing Company. "Right now there are more good pilots than there are good planes for them to fly. But there is an immense field of opportunity in aviation, outside of being pilots."

"Just piloting a plane is a chauffeur's job," said "Merry" Merrill, chief instructor of the Curtiss Air Service. "Anybody can learn to do it, but the big chances in aviation aren't in being a pilot. What are all the war 'aces' doing for a living now? Are they pilots? Eddie Rickenbacker isn't, for one. And Lindy certainly isn't going back to pushing a plane over a mail route. Everybody ought to learn to fly, just as everybody ought to learn to drive a car. But the proportion of those who earn their living by piloting planes is going to be about the same as that of those whose main job is driving a car."



Clarence M. Young, chief of the Air Regulations Division, U. S. Department of Commerce, is shown at the extreme right in the upper photograph explaining an airplane vibration testing machine to students on a visit to the Guggenheim School of Aeronautics, New York University. At his right is Prof. Alexander Klemin, director of the school. In the lower photo Young, Professor Klemin and students are inspecting wind tunnel for testing planes

There are plenty of interesting and profitable things a chap can do with an airplane, but for the great majority who go into commercial aviation the big opportunities are on the ground. "Get it out of people's minds that aviation is merely an adventurous kind of sport, and into their minds that it is a more rapid means of transportation, and we will begin to get somewhere in the development of air transit," said J. W. Miller, Secretary of the Daniel Guggenheim Fund for the Promotion of Aeronautics.

There is the key to the big opportunities in aviation. Transportation—carrying something, people or goods, from one place to another. Banging up of air organizations, development of ports, charting of lines of travel, improvement of aircraft—these are the things that some of the biggest men in the country, commanding big money, have decided shall be done. The new opportunities lie in helping carry out this program.

Let's start with the improvement of airplanes. I asked a dozen or more experts what airplane inventions or improvements were needed. Here is the list I gathered.

A METHOD of making duralumin noncorrosive when exposed to salt water; or a new alloy equal to duralumin which will not corrode.

Simpler engines of equal or greater reliability with the best now made; perhaps of the two-cycle type, perhaps engines of the Diesel type, using low-grade fuel.

An effective muffler for the engine exhaust, which will not reduce the power output.

Better protection against fire; perhaps a nonflammable "dope" for fabric-covered planes.

Improved parachutes and other safety devices.

Radio apparatus with longer range and of lighter weight.

All agreed on one outstanding need of aviation, which offers the widest field for inventive effort—improved design. Somebody must—and somebody will—build ships which will land at thirty-five miles or slower, use not more than 300 feet of space for landing and take-off, maintain flying speed as low as thirty-five miles an

Sixteen young women make the Chicago Women's Flying Club the largest class of aviation students of the fair sex. Mrs. E. Lewis Campbell, president of the class and an instructor in white, is seen bending over the controls, giving some members points in management of a plane under various conditions

A rather interesting sight now a commonplace one in five years. An airplane being loaded on the outskirts of New York with hundreds of pounds of express matter consigned to Chicago. This is the means of transport when speedy delivery is wanted

hour and a diving speed not much greater, and be so stable in the air as to return automatically to correct flying attitude when subjected to sudden wind currents. These are the ideals of performance set up as a standard to aim at in the competition for the Guggenheim prize—one of $100,000 and five of $10,000 each—which is open for competition until the end of October, 1930.

The airplane that wins the $100,000 prize may look entirely different from any plane now being flown. Dorner in Europe and Henry Ford in America have announced huge planes carrying 100 passengers for the near future. I asked Prof. Alexander Klemin, Director of the Guggenheim School of Aeronautics of New York University, whether such huge planes were practicable.

"THE larger the planes themselves, the less need there is for the tail," he said. "I would not be surprised to see a big plane developed without any tail at all; I think that is the direction in which we are moving."

In the development of new plane and engine designs and of the different items I have listed, the opportunities are unlimited for the young men who will begin to qualify now. And the way is open to qualify. That way is to study aeronautical engineering in one of the five great schools which now give thorough courses by aid of Guggenheim grants—New York University, Massachusetts Institute of Technology, the University of Michigan, Leland Stanford University and the California Institute of Technology.

Air morning de luxe. A waiter serves light luncheon and liquid refreshments in one of the huge twenty passenger planes on the London-Paris route service that will in a few years be duplicated or surpassed by many air lines now projected in the United States

Four years of hard work in college, and the summers spent in airplane factories and in learning to fly—with that preparation there are jobs waiting for you now and there will be many more four years hence.

All of our graduates have found places at once in aircraft factories," Professor Klemin told me. "They have started in at salaries ranging around $65 a week."

That is a good deal more than the average young engineer, just out of college, gets in any other line of industry.

"We take the aeronautical engineers from the M. I. T. as fast as we can get them," said Russell of the Curtiss company. "The construction of a modern plane is not done under the supervision of just one engineer, but of many, each a specialist in one particular phase. After we had finished the wind tunnel tests of models for the *Condor*, and agreed upon a design, the construction was delegated to ten engineers, each charged with designing one particular part. And on a plane designed to weigh, with full load, some 10,000 pounds, the finished job was only sixty pounds heavier than we had calculated."

Electrical engineers are needed in the industry and thousands more will be within five years. The young man who begins to qualify in electrical engineering now, with a special eye to the electrical problems of aviation, has a chance like those which Edison, Tesla and Marconi found and made their own. Only an electrical engineer like Morris Titterington could have conceived and designed the earth inductor compass, which enabled the trans-Atlantic flyers to find their way across the ocean and which will be an essential part of the equipment of every future long-distance flight.

ELECTRICITY in some one of its applications holds the solution of the problem of safe flying in the fogs which are the most serious handicap to aviation today. I asked Professor Klemin how he thought the problem was most likely to be solved.

"Somebody may find a means of dispelling fog by electrically charged sand strewn from a plane, with which experiments have been made," he said, "but so far nothing practical has come of this. For the present we must depend upon improvement in field lighting and in radio signals. I believe it is possible to devise a system of marking light candela, so that invisible rays of the lighting systems of airports and intermediate fields will be

(Continued on page 142)

The whirling chair tests a Guggenheim-New York University student for fitness for the flying unit. After the whirl Major I. B. Marsh examines the subject as to pulse and dizziness. If he passes this examination and others he is fit to fly

Know Your Motor Car

A SPEEDOMETER is an indispensable motor accessory—the only check you have on oil, gas and tire mileage. Yet many automobile owners don't give speedometers the care they need. The head of the speedometer, which houses the mechanism, should never be tampered with, but you should lubricate the drive shaft every few thousand miles. Unscrew the knurled nut that holds the upper end of the shaft to the head and squirt transmission oil into the hollow sleeve around the links that make up the shaft. A properly lubricated shaft will last much longer.

The constant jarring tends to impair your speedometer's accuracy. Have it tested after each five thousand miles.

Half Plane Half Dirigible

FIVE hundred passengers would be carried by a proposed airplane-dirigible that would dwarf the largest flying craft now in existence! Its curious bloated hull, 780 feet long, would enclose 4,500,000 cubic feet of gas, making it only slightly heavier than air. The rest of its weight would be carried by five sets of wings each 600 feet long!

Eleven motors are designed to drive as many propellers, flying the ship 150 miles an hour. It could take the air and land at slow speed by virtue of its hybrid balloon feature. A trip from America to Europe would require fifty two hours, says its inventor, Claude H. Freese, of San Francisco. His model, shown below, is based on his twenty years' experience in the Zeppelin works in Germany.

With five sets of wings and eleven propellers, an airplane-dirigible 786 feet long would carry 500 passengers, according to Claude H. Freese, its designer, pictured here with his model

Thermos "Food Trolley" Carries Hospital Meals

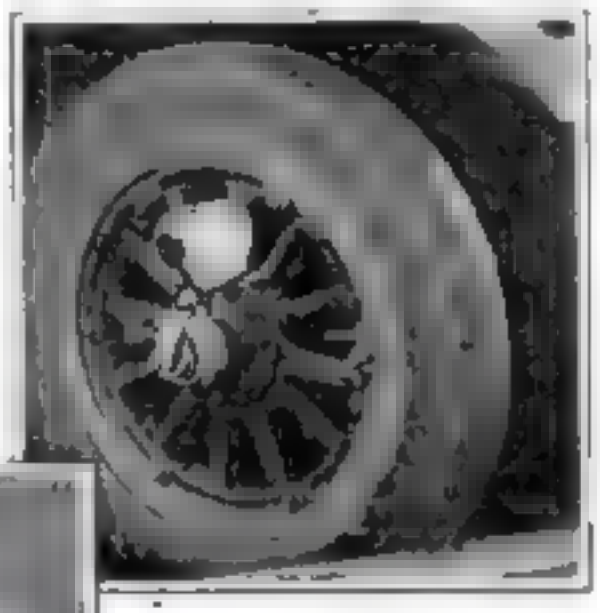
LIKE some giant thermos bottle, a new heat tight box is now used as a "food trolley" in Bolingbroke Hospital, Wandsworth Common, London. Insulated compartments side by side within the box keep hot foods hot and cold things cold en route to the patients. The three-wheeled container, shown leaving the kitchen, has convenient handles that guide it down long corridors.

Mica the Versatile Mineral

CHRISTMAS tree "snow" and imitation granite surfacing for stucco walls are among the varied products made from mica, the transparent mineral that windows the peepsole of your furnace. Huge quantities of the sheet-forming mineral, valued for its resistance to heat and electricity, are used in radio condensers and other electrical apparatus. For its resistance to shock, it is used in motor goggles and in conning towers of warships. Its resonant qualities adapt it to diaphragms of phonographs.

Most of our mica is imported. India producing half the world's output. Here, New Hampshire is the leading producer of sheet mica, and North Carolina of fragments known as scrap mica.

Heat-tight and cold tight "food trolley" leaving kitchen in Bolingbroke Hospital, Wandsworth Common, London, with food to reach patients either piping hot or frosting cold



Safety in Hub Light

HERE'S an unusual lamp that shows you the right-hand side of the road when you drive at night regardless of glare from the headlights of an oncoming car. It keeps you from running off the road, and shows just how much room you can give the other fellow. You can dim your lights so that they will not blind him without reducing your own vision.

The position of the lamp—on the hub of the right front wheel—is made possible by drilling a hole in the hub cap and attaching the lamp bracket to the axle, which does not turn. It throws a bright beam of light just where you need it—directly in front of the wheel. When the wheel is turned, going around curves, the light follows it.

Electric Eye Runs Factory

A NEW use for the photo-electric cell—a sensitive device that transforms changes in light intensity into electric fluctuations—has been found by a Kalamazoo, Mich., paper mill. One of these cells is placed beneath the continuous roll of paper that travels through the factory, and automatically adjusts the machinery when the paper is getting too thick or too thin. The difference in the amount of light transmitted by the paper sets the device in operation.

Sharks Die in "Sea Desert"

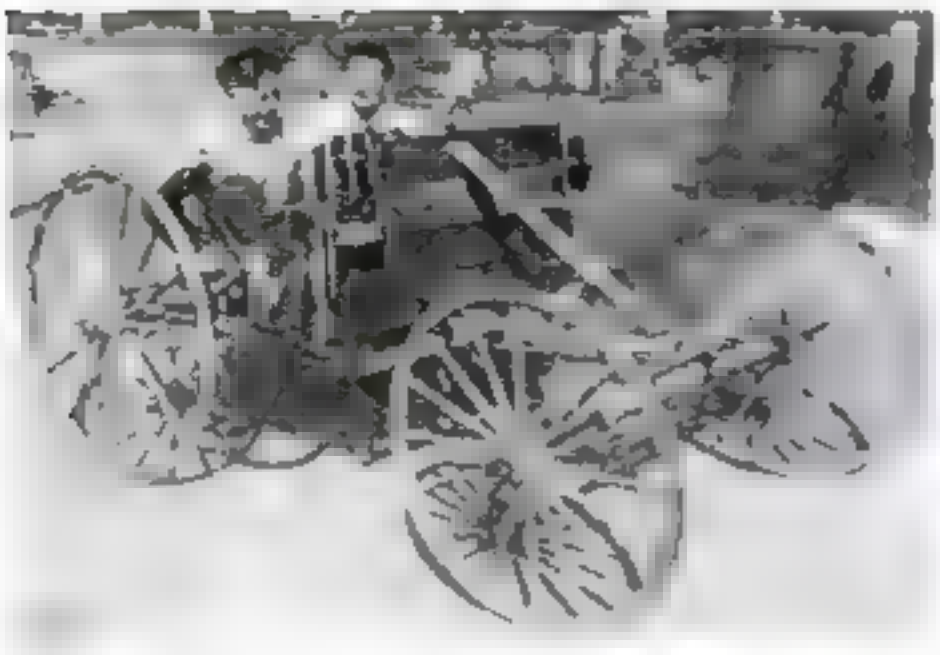
IN THE south Pacific Ocean has just been discovered the most desolate spot in the world. According to Dr. Austin H. Clark, who helped chart it for the Smithsonian Institution, the place is devoid of any kind of life—either in the surface waves or at the bottom. No region on land is comparable with its lifelessness. Ear bones of whales and teeth of sharks on the red clay bottom are the only remains of sea monsters that strayed into the "sea desert" and perished.

Color Photography Nearer

NATURAL color photographs on paper are brought nearer by a new process in which yellow, blue and red prints from separate negatives are made in succession upon a single sheet. The tones are obtained by an ingenious choice of color-forming chemicals used to sensitize the paper before each printing.

Trees Fight for Lives

TREES are continually fighting for their lives. There are 200,000 known varieties of insects that attack them.



Reminiscent of the first "horseless carriages" is this motor car built of junk. It is seen being turned around by its novel steering system of pulleys

The $18, homemade, three-wheel motor car of Gayle Lockhart, which, with its low-hung construction, is said to make 65 miles an hour safely

Autos Built at Home of Junk, Resource and Ingenuity

WHERE there's a will to have an automobile there's a way, even if there is not so much cash. Two men have recently become motor car owners at costs of fifty cents and $18.

With half a dollar's worth of junk, Kenneth Shand and Billy Van Zant, California boys, put together a machine that actually runs—with one of them at the wheel and the other shifting gears! It is steered by a novel system of pulleys.

Gayle Lockhart, of Los Angeles, built his car at a cost of $18, using motorcycle and automobile parts. He claims speed of sixty-five miles an hour. Despite its swiftness, the three-wheeled machine is said to hold the road well by virtue of its low-hung construction.

Frame of Giant Air Liner

MORE than a hundred passengers will be carried by a giant air liner which Herr Rumpler, noted German airplane builder, says he will construct. It will have a crew of thirty-four. The illustration shows the designer with a model of the duralumin framework to be used in its construction.

Wave Lengths of Elements

AT A new spectroscopic laboratory of the U. S. Bureau of Standards, the wave lengths of all the chemical elements will be measured for a permanent record of each substance's properties. No two elements have exactly the same wave lengths when the light from hot samples is examined with the spectroscope.

This classification enables workers to detect minute impurities in metals where chemical analyses fails. With the wave length charts astronomers can determine what stars are made of.

Previous studies at the Bureau have measured the wave lengths of most known substances, including the new element hafnium, so rare that it is almost impossible to obtain.

A Bridge That Alters Shape

THE world's longest concrete "bow-string" girder bridge, it is said, has just been completed at Bagneux, on the outskirts of Paris. Its 280½-foot arch alters its shape under heavy loads and temperature changes. One end is pivoted upon its supports while the other can slide forward or back.

Noisy Oysters Spoil Survey

DESPITE their proverbial reputation for silence, oysters recently forced the U. S. Coast and Geodetic Survey to change its plans for charting the Atlantic shore between Cape Hatteras and Cape Lookout, N. C. To determine accurately the position of the survey ship, underwater sound waves were to be used, as elsewhere; but when the delicate acoustic instruments were made ready, they registered only the clicking "static" of oysters opening and shutting their shells.

Joint experiments by the U. S. Bureau of Standards and the Coast Survey developed the sound wave method. When the survey ship explodes a miniature "depth bomb," underwater sound waves reaching several shore stations in turn automatically flash back an instantaneous radio signal. With a map and a stop watch the ship's officer can thus determine his distance from each shore station and hence his exact position—wherever oysters are not too numerous!

Plane Crash Harmless Here

PLANES need not fear running afoul of a new type of landing field "blinker," invented by W. G. Fuller of the Municipal Airport at Fort Worth, Texas. Its standard is flexible and should a plane run into it, only a broken lamp globe will result. The old type lamps were mounted on rigid standards, and several planes making night landings were damaged. Other fields in the Southwest are adopting the new lights.

Earth's Speed May Vary

THAT the spinning earth, like the average man, has its lazy days and slows down now and then, later making up for lost time, is the remarkable theory recently advanced by Prof. Benjamin Boss of the Dudley Observatory, Albany, N. Y. This, he told members of the American Astronomical Society, would account nicely for errors that he found in the Greenwich Observatory's calculations of the earth's speed. These errors, which were noted also by Prof. E. W. Brown of Yale University, had been ascribed by him to repeated minor inaccuracies of observation.

Traffic Paint Endurance Test

HOW long will a white traffic line stand up under heavy traffic? To find out the best kind of paint, the U. S. Bureau of Standards recently used a dozen samples to mark a Washington, D. C. street. Those that withstand the friction of countless automobile tires will be adjudged the best.

"Hot Dogs" Capture England

NOW the "hot dog," famed American article of diet, has spread to England, and through promotion efforts of a newly formed syndicate in London is attaining wide popularity. To satisfy the British Board of Health, wax containers for the familiar sausages and rolls have been adopted. Reports say that the English "hot dog" appears in the highest society at sporting events, a prestige unknown to its democratic American cousin.

Trees Cast "Radio Shadows"

QUEER facts about extremely short radio waves were discovered during recent tests on a five-meter transmitter of the General Electric Company to find its applicability to aviation. So great was the waves' frequency, it was found, that the ripples traveled in straight lines like light beams. Trees, buildings or hills intervening between the transmitter and the receiver cast "radio shadows," or "dead spots" within which no signals could be heard.

Rubber Horseshoes

RUBBER shoes for horses and mules are rapidly gaining favor, and the U. S. Department of Agriculture advises their use to protect the animals' feet wherever necessary. Shock of hard pavements is reduced and the new shoes are "ready-to-wear," a convenience in the present-day scarcity of blacksmith shops. On treacherous surfaces the rubber horseshoes are said to be "no good."

Native Foods Best

EIGHT vegetables that were first grown here by the Indians now produce crops more valuable, according to the U. S. Department of Agriculture, than those of the whole twenty-four important ones that we have imported and domesticated in this country. The original American vegetables, raised by the red men, were beans, corn, peppers, pumpkins, squashes, tomatoes, potatoes and sweet potatoes.

From the Old World first came the cucumbers, eggplants and muskmelons that we are accustomed to see on our table. Watermelons, okra, asparagus, beets and Brussels sprouts are of European origin, as are cabbage, carrots, cauliflower, celery, kale and collard, and kohlrabi. Among other foreign vegetables are ruffleleaf lettuce, leek, onions, parsley, parsnips, peas, radishes, salsify, spinach, and turnips.

A Boat That Can't Capsize

A BOAT within a boat is the unsinkable life-saving craft recently demonstrated at Belfast, Ireland. Even if a wave should tip it completely over, the passengers would remain dry, it is said, for the inner chamber is so hung that it always remains level. Within the smaller craft is a mechanism for righting the outer shell whenever this happens. In the illustration below the new lifeboat is being deliberately tipped over; the swinging compartment that carries the occupants is retaining its upright position.

The inner compartment of the life-saving boat remains level, as shown in the picture, when the outer shell is tipped over, which is being done here in a demonstration. Mechanism is provided to right the outer part

Bicyclist Has Trailer to Carry Children

IT'S easy to take the children for an airing when you know how! A Frenchman devised this novel trailer to be attached at the back of his bicycle. Now he puts his youngsters in the wide carriage seat, buckles them in with a strap, and pedals along the boulevards.

A Window-Envelope Contest

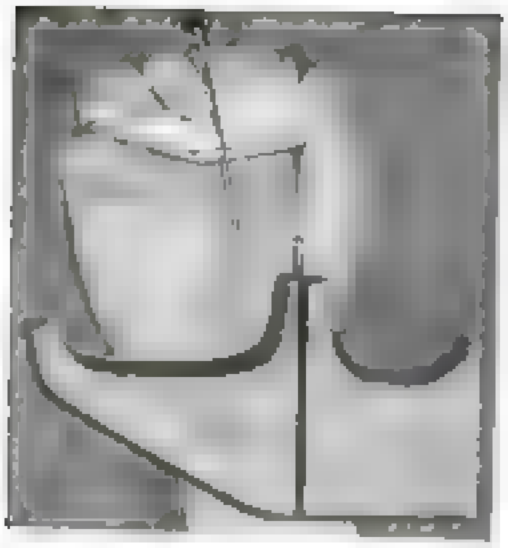
JUST what makes a good window envelope—the sort with a transparent strip to read the address inside—has recently been studied at the U. S. Bureau of Standards. Such envelopes, made by impregnating a space on their front with oil or varnish to make it transparent, were found satisfactory if kept cool and dry, though separate "windows" of "gassine" paper were more permanent. Objectionable gloss, likely to cause eyestrain, was measured with a "glarometer," the transparency, and liability to crack when folded, of the windows were also determined for various materials.

New Air-Mapping Invention

BY THE use of an entirely new system of air mapping, Dr. Reinhard Hugershoff, German cartographer, hopes to be able to revolutionize the art. He plans to demonstrate his invention at Washington, D. C., where Government officials who are considering remapping the whole United States will provide him with an airplane, an expert pilot, and a photographer to try his scheme.

Special stereopticons would project his airplane photographs on a large drum, where they would show a "stereoscopic" effect that would instantly differentiate hills and valleys, he explains. Starting at a single point of known elevation, a contour line could be drawn touching all points equally high. Extensive land measurements would be unnecessary; Dr. Hugershoff says that his system requires only three actual measurements for every 65 miles.

New Products *of the*

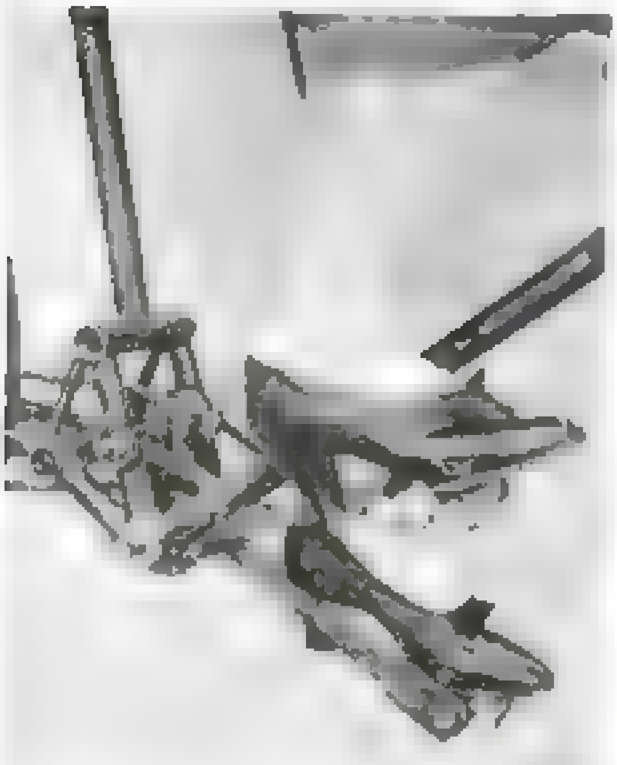


How to Tame Balky Wires

To pull an unruly electric wire through a wall a new tool reaches in and grips the wire end between its two viselike halves

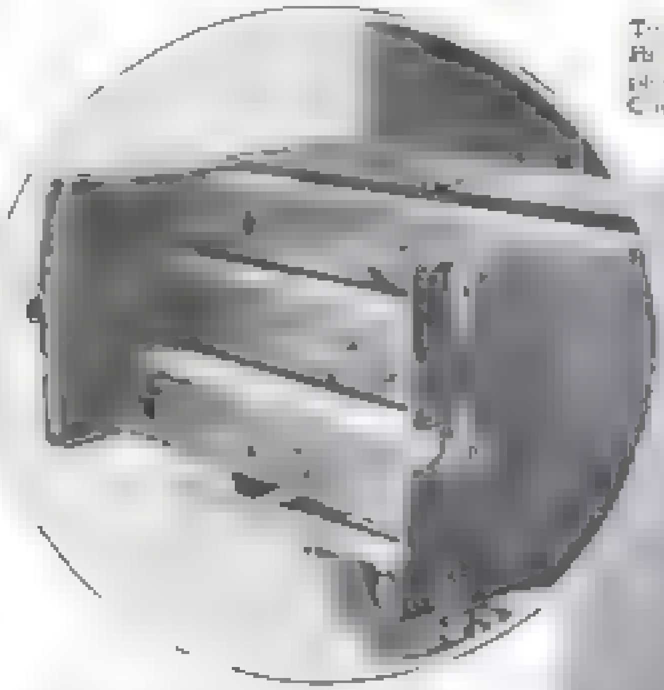
Plow Lays Radio Wire in Furrow

To lay ground wires for a broadcasting station the [illegible] plow which [illegible] the wire [illegible]. Covering the wires with earth was quick and easy



Ratchet Gives Bicycle High Speed

The ratchet drive of the bicycle invented by Rene [illegible] of Paris, allows the pedals to be worked up and down instead of around, saving time and energy, it is said. Fifty mile an hour speed is easy



Three in One Motor Trunk

A touring trunk for three persons or one [illegible] three are arranged like drawers in a chest. When [illegible] they may be used for [illegible] travel as [illegible] [illegible] a lock and handle

Glass Violin String Case

Long glass tubes have been invented [illegible] to [illegible] damage [illegible] and [illegible] them. The tubes [illegible] a larger tube [illegible] easy for the player to examine them [illegible] and select the one which he is ready [illegible] use

Lightning Shorthand Typewriter

A new French shorthand typewriter prints [illegible] characters on a [illegible] words a minute [illegible] faster than the ordinary methods. Light in weight as the one shown, the machine has twenty one keys and can be operated with one or both hands. It is now in use in the Paris courts, the Chamber of Deputies and many of the offices

Alarm Clock for Dozing Aeronauts

With an altimeter or height register built into it, this clock will let a balloonist sleep and wake him if his [illegible] below a set point. When the altimeter reaches the danger point it sounds an electric buzzer and if the ground is approached it flashes a light signal. The device operates regardless of [illegible] other atmospheric conditions. Ward T. Van Orman, the inventor, himself a balloonist, is shown in the picture with his machine, which has been tested successfully

World's Workshops

Machine Skins Wire in Hurry

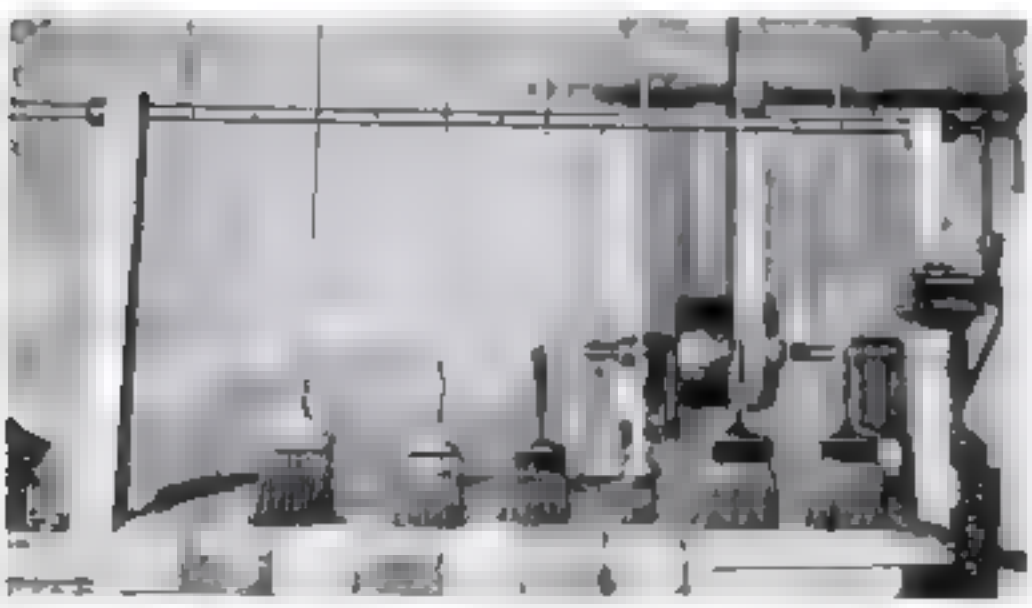
Time is saved in taking insulation off an electric wire by the machine at the right. Close the pliers by hammer and one end grips the wire, the other with two hot knife blades, strips the coating off clean

"Halfway to Heaven" on Fire Ladder

No place for a person who gets dizzy in the new extension ladder these young women helped the Los Angeles fire men test. Despite its frag le appearance, it is quite safe

New Economical Label Licker

To the business end of this English label and gummed paper is fastened a piece of felt. When it is applied the pressure releases water from the reservoir to the back of the felt. When the pressure is released the reservoir is closed



Machine Tests Paint Brushes

To test their life and endurance, a Wooster, O., paint brush plant attaches its brushes to a revolving shaft, which makes them do millions of strokes, which are counted automatically

Dustless Street Cleaning at Last

Boston has started a street cleaning service that [illegible] Machines of the vehicle type [illegible] The brushing [illegible] When a [illegible] as When the dust is settled they are [illegible]

A Mirror That Tells Your Height

This remarkable mirror installed in a Portland, Ore., store, has a scale so placed that the figure at the point where your eyes are reflected gives your height. The arrangement is possible by reason of the fact that the elevation from the eyes to the highest point of the head is almost exactly the same with all persons, regardless of height. The device has proved correct so far

Snail Is a Rip Van Winkle, Sleeping for Twenty Years

TWENTY years of continuous sleep! That is the amazing slumber mark held by a land snail, the property of Walter F. Webb, of Rochester, N. Y. It followed another ten years' dormant stretch, terminated one summer when Webb revived the snail. Now it has equaled Rip Van Winkle's fabled record and still seems able to sleep indefinitely

Copper Hardened for Knives

FAR from being a lost art, as many suppose, the hardening of copper is daily practiced by modern metallurgists. Copper scissors, knives and other cutting tools are used in a few places where they possess special advantages over steel. Alloying and "cold working," the two methods used centuries ago, are still employed successfully; a recent new way of hardening copper is by the addition of silicon, a nonmetallic chemical element, to copper-containing alloys.

Lion "Packs" Hardest Punch

THE impact of a lion's paw, the flip of a whale's tail, and the kick of a giraffe are said to be the most powerful blows that animals can deliver. The lion's is the most forceful, upholding his title as "King of Beasts."

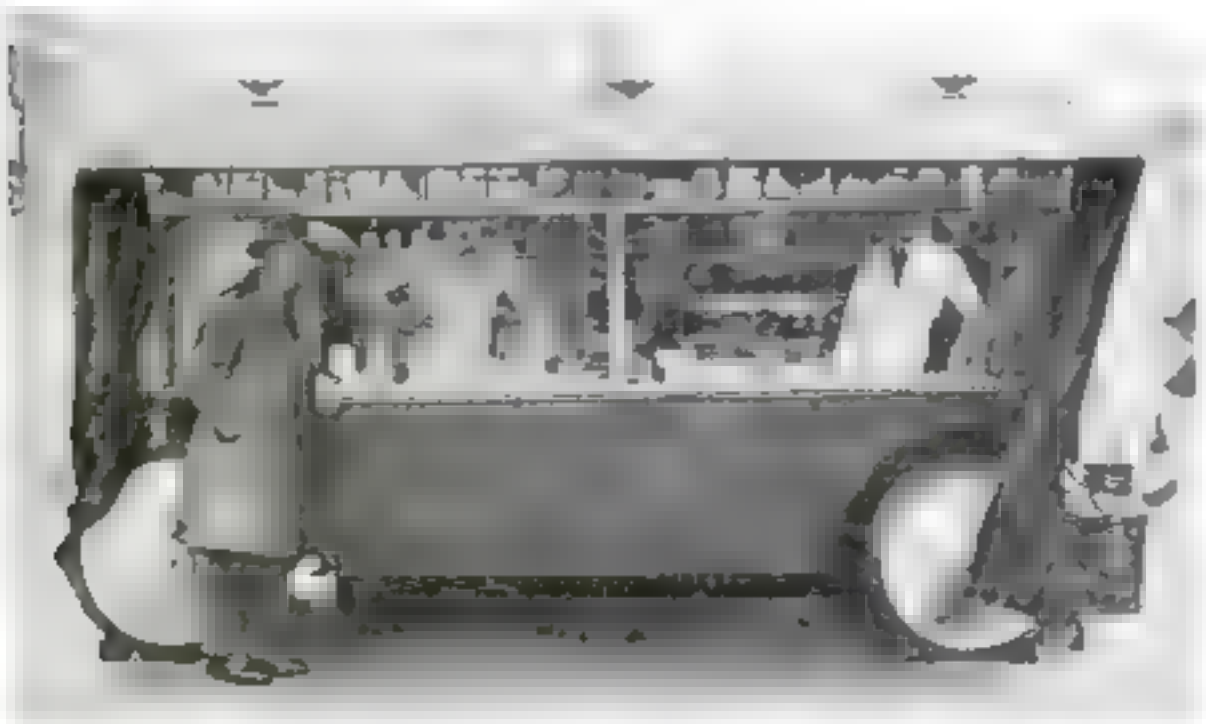
Lunch Wagon Trails Patrons

"FOLLOW the trade" is the motto of a novel lunch wagon, and it observes it literally by rolling itself to wherever the trade is liveliest. It is a motorized coffee stall, which appeared recently on London streets. Its specialty is catering to the night workers and the theater-goers, many of whom do not wish to buy expensive dinners at a restaurant, but just a cup of coffee and a sandwich.

The advantage of the motorized lunch stand is its mobility, by which it can move in a few minutes to whatever section demands its trade. In all other respects it is neat and modern and just as attractive as those of its competitors which are rooted to their foundations.

Champion Woman Nail Driver

DID anyone say a woman can't drive a nail straight? Some can't, perhaps, but not Mrs. Benjamin F. Rennard, champion woman nail driver. She won a recent contest at Philadelphia in which thirty women competed. Each drove five nails into a plank, Mrs. Rennard took the shortest time.



Wherever night workers finish their shifts at theaters dismiss their audiences in London the motorized coffee stall rolls up to serve the crowd. It solves the problem in districts where there are no restaurants and in those where there are only cafes that are hard on slim pocketbooks

Skeleton Plane for Novices

WOULD-BE fliers soon learn the inside workings of a plane with the aid of this novel skeleton craft, used for the instruction of German pilots. All the parts can be seen in operation, and the student can master the "how" and "why" of the controls long before he actually takes to the air. He sits with the demonstrator in the cockpit and tests for himself the effects of the various levers and gears upon the plane's parts.

Two-Mile Bridge Projected

SOON the longest bridge in the world will cross an arm of the Baltic Sea, according to reports from Germany, to connect the island city of Rugen with Stralsund, on the mainland. It will traverse more than two miles of water, making it the longest railroad bridge ever built. Its hundred-and-five-foot height will permit heavy boat traffic beneath its nineteen long spans.

Crickets Chirp Temperature

THAT crickets are vocal thermometers is the astonishing conclusion of Bert E. Holmes after a four-year study of the insects. You can tell the temperature, he says, by timing the frequency of their chirps. His formula is: "The prevailing temperature in degrees Fahrenheit equals the number of chirps made in a quarter of a minute, plus thirty-seven." This remarkable way of telling the temperature, the reason for which is imperfectly understood, is said to be accurate to about one degree.

"Snowy white" or tree crickets, another observer points out, are the ones to use as thermometers. The common cricket's chirps are more irregular.

Industry Shifts Westward

AGAIN the center of industry of the United States has moved westward. The latest survey of the Department of the Interior finds a spot about fifty miles southeast of Chicago is now the mid-point of industrial development.

The real, or geographic, center of the nation lies near the middle of Kansas' northern boundary. The center of population is in Owen County, Indiana.

Sprinter's Sprinting Family

FIVE children of Arthur Duffey, of Boston, first sprinter to run 100 yards in 9⅘ seconds, show promise of following in their daddy's athletic footsteps. This sight may be seen on roads near Boston almost any morning.

Under the coaching of Duffey Arthur, Jr., oldest, has achieved something of an athletic record at Arlington Junior High School, Boston, in football, baseball and hockey. He can run 100 yards in eleven seconds, although only fifteen years old. John, Helen Louise, William and Roger, reading from left to right, all show promise.

X-Rays Speed Evolution

IF RECENT discoveries of X rays' effects on fruit flies, made by Prof. H. J. Muller, of the University of Texas, prove true for other creatures, he will have speeded up evolution a hundred times! Under the rays the flies offspring include an extraordinary number of freaks, or 'sports,' with modified characteristics—wings altered or body of unusual shape.

Such sports occur in Nature, but very rarely. They are believed to be the founders, by evolution, of new races. Cattle breeders select such individuals, if they are superior, to improve their stock. Professor Muller has suggested a speeding up of Nature that may be applied to the entire animal world.

"One Way Windows" Invented

BY ADDING to glass extremely thin films of gold, an English inventor, S. Cowper Cowles, has recently found a means of making "one way windows." They are said to be transparent and of a pleasing greenish color to a person looking out, but one trying to look in sees only an opaque burnished gold panel.

A Theater Curtain of Water

WHEN the curtain is due to fall at an outdoor theater recently completed in Philadelphia, they turn on the water! The descending liquid wall, from an overhead pipe at the front of the stage, forms an effective and beautiful screen. Colored lights play upon the waterfall while the "curtain" is "down." To "raise" it, the water is simply shut off and the stage is again visible.

World's Smallest Scissors

THE miniature scissors shown in the photograph above have been produced by a Los Angeles manufacturer, who calls them the smallest working shears in the world.

The blades, which are less than an inch long are of good steel and may be used for fine cutting that is impossible for shears with larger blades.

Ready to Breed Supermen, Says Noted Gland Expert

BY THE transplantation of glands, Dr Serge Voronoff, noted surgeon, proposes to create a race of supermen! In a recent amazing address to the Zoological Congress at Budapest, Hungary, he told of his successful experiments with aged rams whose lives he had prolonged, and whose offspring yielded more wool.

"Give me children endowed with the spark of genius," he said, "and I will breed a race of supermen. The mother who is the first to hand me her child for a rejuvenation operation perhaps would be the founder of a new and mighty human race."

Building a Hippopotamus

THE first lifelike mounted hippopotamus to grace a museum, on display at the Field Museum of Natural History, Chicago, is really not a hippo at all! The peculiarity of the hippopotamus' skin, taxidermists say, makes it appear unnatural when it is preserved. So Leon L. Walters, the museum's taxidermist, and inventor of a celluloidlike substance that he had to use to model snakes, molded from the skin of a real hippo a "celluloid" reproduction. This "synthetic hippo" is said to be superior to the genuine, not only does it deceive the eye, but it is more lifelike and a better object for study.

A Church on a Chassis

A MOTOR car once used by liquor smugglers has been converted into the rolling church or "Gospel Patrol" shown in the photograph below with Lawrence E. Greenwood, evangelist, at the organ on the extension platform at the rear of the vehicle.

Greenwood started his work at Wiscasset, Me., where a tabernacle was built and many foreign missions were sent out. Then the minister acquired the chassis of a rum runners' car and built upon it the unique rolling church, with which he tours Eastern states, visiting not only cities, but tiny communities having no churches of their own.

Into the highways and byways goes this Gospel Patrol, built on the chassis of a car once used by bootleggers. Lawrence E. Greenwood, of Wiscasset, Me., the minister, is shown at the organ, which is carried inside and brought out onto the extension platform when services are to be conducted

Gigantic Water Lilies

THE largest and most beautiful water lilies grown are claimed by the Georgia Experiment Station at Griffin, one of whose gigantic blossoms is exhibited here. The flowers are not only far beyond normal size but they have a delicacy of texture and faint coloring that is said to be unequaled.

Mucready May Win Record

THAT America, through Lieut. John A. Macready's flight of last year, may hold the world's altitude record for airplanes is the consequence of recent charges by the Aero Club of France against Jean Callizo, French flyer. The club expelled Callizo and voided all his records, including the world's record of 40,820 feet, on apparent proof that he "faked" a barograph chart with invisible ink to show a new record in his latest flight. Another barograph, concealed in his plane by a Bleriot engineer, registered less than 14,000 feet.

Should the International Aeronautical Association, world aviation authority, support the French Aero Club's action, the world's record will revert to Macready for his 38,704-foot ascent.

Fertilizer Made of Cocoa

IN RESPONSE to the demand for a fertilizer of nonobjectionable odor, the U. S. Department of Agriculture, through researches by its Bureau of Soils, has developed a new, pleasantly fragrant soil enricher. Obtained as a by-product in the manufacture of cocoa and chocolate, it contains valuable agricultural ingredients that remain after the food substances are extracted. Moreover, it has the aroma of a newly opened can of cocoa.

Chicago-Mexico Air Mail

NOW arrangements are nearly completed for an air mail line from Chicago to Mexico City. Harry S. New, United States Postmaster General, is devoting his efforts to the establishment of this latest link between the nations.

Aviation progress in Mexico has been rapid, recent lighting facilities have made it possible for Mexican pilots to fly at all hours of the night as well as by day.

Nickel-in-Slot Soda Water Dispensed in Ten Flavors

NICKEL-IN-THE-SLOT soda fountains have been invented by F. E. Gray, of Philadelphia, who has just put them in operation there and arranged to do so elsewhere. Not unlike the coffee slot machines in operation, the new devices provide ten flavors. Caretakers at intervals put in ice and take out nickels.

Tiniest Iceless Refrigerator

TINY cubes of ice are frozen by the smallest refrigerator in the world—a remarkable model built by L. S. Cooper, of Piqua, O., pictured below. An exact copy of a popular make of iceless refrigerator, the miniature device is only eight inches high. Half an ounce of sulphur dioxide is used as the cooling liquid gas, and one of the valves moves one sixty-fourth of an inch to open and close. The two diminutive trays make twelve cubes of ice each. The condensing coil, behind the flywheel, consists of fourteen coils of one-eighth-inch copper tubing

World's smallest iceless refrigerator. 8 inches high, has a 3-inch flywheel. A half ounce of gas in tiny coils freezes water in the trays

Queer Rivers That Fail in Attempts to Reach Sea

QUEER rivers that never reach the sea, dotting the "Great Basin" of the West, have just been studied extensively by the Department of the Interior. They flow to inland lakes where the water vanishes by evaporation, leaving its dissolved minerals behind. Several thousand square miles of lakes are scattered through the basin, which extends west from Utah to include California and Oregon.

Largest of these lakes is Great Salt Lake of Utah—shallow remnant of the huge prehistoric Lake Bonneville. At another American "Dead Sea"—Searles Lake, Calif.—are great potash beds.

Abroad, the Dead Sea of Palestine, most famous inland body of water, contains more than forty billion tons of valuable mineral salts.

X-Ray Catalogues Minerals

TWELVE-INCH X-ray photographs of crushed samples of every known mineral are to be the basis of an scientific laboratory for geologists, first of its kind, at the University of Wisconsin. Already 170 specimens have been "fingerprinted" by the X-ray to identify duplicates without complicated analysis.

Oil Tanks Made into Houses

RUSTED oil storage tanks, no longer fit for use, have recently been found valuable, when split in halves by acetylene torches, as houses for power pumping stations.

One such power house, near Eldorado, Kans., was constructed of several sections of tanks, mounted on a concrete base and closed at the ends. The house, illustrated below, shelters a fifty-horsepower pumping engine that operates a dozen oil wells. The exhaust pipe is to the right of the front. An underground tank through which exhaust gases pass on the way out permits them immediate freedom—a use for abandoned oil containers of smaller size.

Sections of oil storage tanks, on a concrete base, form this power house, in which oil pumping engines work at Eldorado, Kans. They form roof and sides; only front and rear walls have to be built. A smaller tank in the ground is an expansion chamber for gas, which pipe in foreground releases

Aurora, 600 Miles in Air, Highest Ever Seen by Man

ONE of the highest things ever seen by man, a remarkable display of the aurora borealis, or northern lights, was recently observed by Dr. Carl Störmer, Norwegian expert, who has made a special study of auroras. This one occurred at least three hundred miles above the earth, and parts of it may have been as high as six hundred miles. These streamers ascended far enough to take on a rosy glow from the rays of the sun, already set.

From a study of auroras, experts are able to tell something about the height of the atmosphere that girdles the earth. This latest one seems to show it may extend six hundred miles. So thin, the air must be here, however that its pressure is less than a billionth of that at sea level.

Broadway Glare's 49 Rivals

NEW YORK'S "white way," Broadway, is by no means the only one, according to a recent survey directed by W. D'Arcy Ryan, director of the General Electric Company's illuminating engineering laboratory. More than fifty streets in America are brilliantly enough lighted by electricity to be classed as "intensive white ways." The investigators drew the line scientifically, placing the standard at 300 lumens (equivalent to light given off by a twenty-four-candle-power lamp) for every foot of the street.

How Not to Clean Dress

ELECTRICITY and gasoline did a thorough job of clothes cleaning recently in a house on the Teakwood Dairy Farms, near Bakersfield, Calif., occupied by an employee of A. B. Tieck, owner of the farms. The photograph below shows what was left of clothing and house after the "cleaning."

Static electricity, generated by rubbing of the garments, exploded the gasoline, and three women in the house were severely burned.

Silent but graphic testimony that gasoline is not safe for cleaning clothing. Friction in rubbing clothes in gasoline generated a spark of electricity which exploded the fluid and destroyed a house near Bakersfield, Calif., the remnants of which are seen here. Three women were severely burned

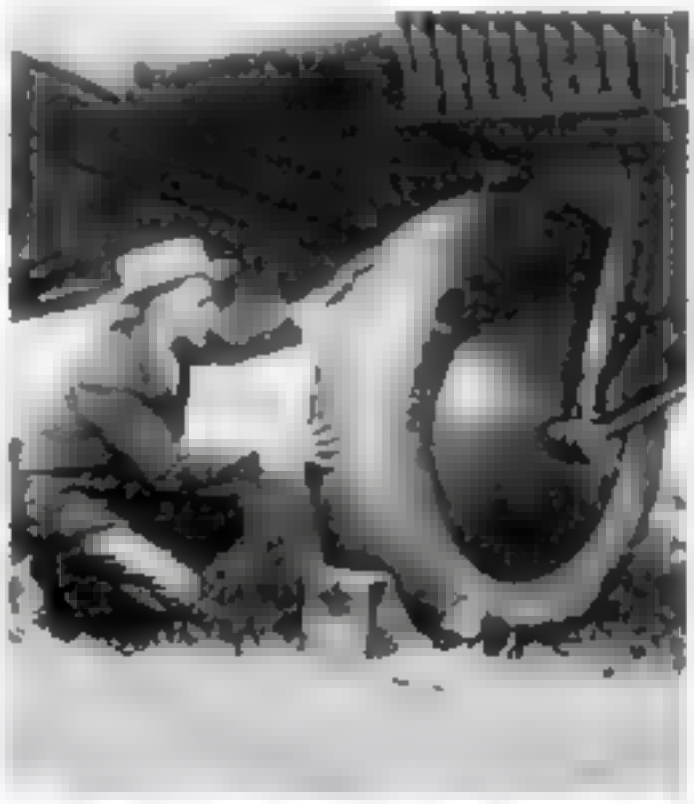
Three Boats Battered to Bits Filming the Colorado Rapids

FIRST motion pictures of the treacherous Colorado River as it swirls through the Grand Canyon were recently brought back by an expedition headed by C. L. Eddy and Frank M. Blackwell, camera man. Twelve college students completed the party.

Three days from the start, Blackwell's boat was hurled against a boulder in the dangerous river rapids and smashed to kindling; the photographer continued cranking until knocked unconscious. Camera, film and operator were rescued. Before they reached the end of their unprecedented three weeks' chute of four hundred and ninety rapids, they had lost two more boats and all their food, and saved the valuable films alone.

A Bomber's Balloon Tires

THESE huge balloon cord tires, as big around as a man's body, take the punishment when the Army's latest bombing plane, the giant "super-cyclops," comes to earth. Their enormous size, as shown below, enables them to withstand a sudden shock of many tons.



Gigantic balloon tires of the "super-cyclops," newest and biggest U. S. Army bomber plane

He Goes Fishing with a Kite

WHEN James W. Jump, millionaire sportsman, goes fishing at Catalina Island, Calif., he takes his kite along! From it is hung, by a long line, a flying fish bait that skims the water in lifelike manner, causing swordfish to rise and seize it. Another line to the pole reels them in.

Year Breaks Health Record

NINETEEN twenty-seven has been a record health year, according to a great insurance company. Fewer persons among the company's policy holders died during the year's first half than in any corresponding period previously recorded. The nearest approach to this health mark was made in 1921.

Measuring between Atoms

EVEN the distance between the layers of atoms in a piece of metal can be measured by a new form of X-ray machine used in metallurgy, Dr. W. P. Davey, of the General Electric Company's research laboratories, recently told the American Chemical Society. With the new device it is possible speedily to predict the properties of untried metal alloys, saving years of actual test.

"Vest Pocket" Balloon Trip

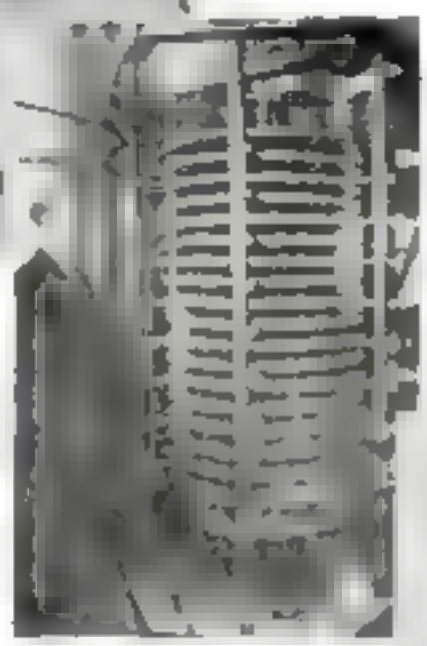
IN A balloon which, when deflated, he could pack on his back, A. Lee Stevens recently made a 350-mile overnight flight to the Adirondacks from Englewood, N. J. So narrow were his quarters that he had to stand erect. Near Lake Clear Junction Stevens released 4000 cubic feet of gas, folded the balloon and boarded a train for Saranac Lake, N. Y.

What Do You Want to Know?

POPULAR SCIENCE MONTHLY is pleased to answer reasonable inquiries on subjects in its field. Send stamped, self-addressed envelope to Information Department, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

Cooling Huge Radio Transmission Tubes

The powerful blower fan in WEAF's radio transmission station at Bellmore, N. Y., cools 4,000 gallons of water hourly



Note the size of this fixed condenser of the Bellmore radio station compared with a man of average size who is shown standing beside it

FOUR thousand gallons of water are cooled each hour to keep down the temperature of the giant tubes at radio station WEAF's new fifty-kilowatt transmitting station in Bellmore, N. Y. The great water cooler is equipped with a huge blower fan that chills the circulating water much as does an automobile's radiator

Another striking feature of the new radio station is a set of huge fixed condensers. Though each stands higher than a man, its actual capacity is no more than that of the tiny, inch-square condensers used in small radio receivers.

These pieces of equipment and many others in the Bellmore station, designed and perfected by some of the foremost radio engineers of America, make the station one of the most efficient of its kind in the world. Yet plans are already under way for improvement, and so rapidly is the science of radio advancing that the plant may be utterly changed within a short time.

Gas Made from Water By New Electric Cell

ECONOMIES in manufacture and transportation of gas are promised by a new high-pressure electric cell that manufactures it from ordinary water alone. It has long been known that when strong electric currents are passed through water, hydrogen and oxygen gas are produced at the electrodes. The new cell, invented by two German experimenters, is the first to produce the gases on a commercial scale at pressures up to a thousand atmospheres.

Recent experiments have shown this compressed gas suited to long distance transmission.

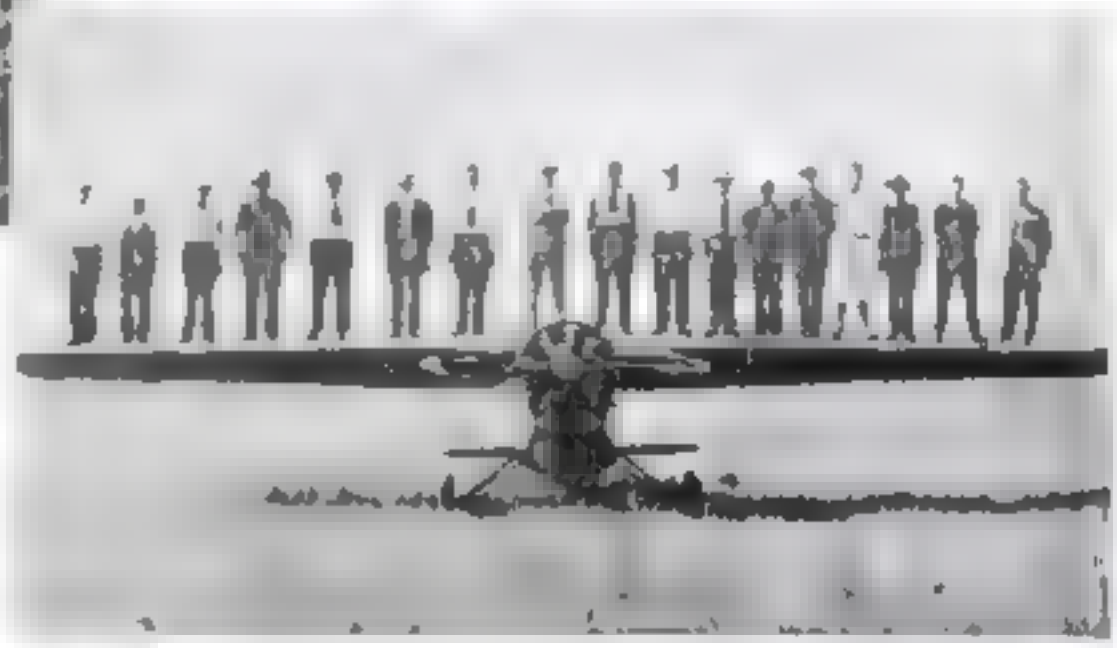
Nearly 5,000 Aviation Pupils

SEVENTY-NINE flying schools throughout the country have a total enrollment of 4,739 students, a recent questionnaire discloses. Army aviation training camps say more than 1,700 Air Corps Reserves, National Guard and R. O. T. C. students took summer courses.

Airdrome Afloat Near Completion

WITHIN the next six months, the U. S. S. *Lexington*, largest and highest powered naval vessel in the world, will be ready to put to sea, reports say. Shipbuilders are putting the final touches on the tremendous airplane carrier at Quincy, Mass., where she was launched two years ago.

Originally the *Lexington* was to have been a battle cruiser, but disarmament plans changed her to a mother ship for aircraft. She is 874 feet long, with the entire deck a flying surface. Elevators that hoist planes from storage in the hold stop flush with the cleared deck to make this possible. Steam-electric power includes electric motors developing 180,000 horsepower, giving a thirty-three-knot speed.



Although struts are dispensed with in the monoplane at the right, thus aiding speed, internal cantilever braces hold the wings so strongly that 17 men can stand on them, as shown

Monoplane's Unstrutted Wings Hold 17 Men

SEVENTEEN men recently stood on the wings of a new type of monoplane near New York City to demonstrate in a striking way its builder's claim that struts to brace them could be eliminated. This cuts down the wind resistance and consequently increases the plane's speed. According to its builder and pilot, C. V. Cessna, it can do 150 miles an hour. Internal cantilever braces keep the wings from sagging, even under such a severe and unusual test.

Earth Tides Likened to Sea's

BECAUSE it is by no means rigid our earth's crust rises and falls like the ocean's tide under the gravitational attraction of the moon and sun. There is no doubt that this occurs, says Dr. Walter D. Lambert, of the U. S. Coast and Geodetic Survey, though difficulties have so far prevented exact measurement.

Another thing that makes the crust of the earth heave and fall, says Dr. Lambert, is the pressure exerted upon it in spots by the rising tide of the ocean. Atlantic tides have caused an observed earth bulge at Williams Bay, Wis., 800 miles away, and it is thought probable that this influence girdles the earth.

When Sea Gets Out of Gear

HUGE waves or swells that rise unexpectedly out of a calm sea, such as the one that recently rocked the liner *France* as it was about to enter New York harbor, are explained by G. W. Littlehales, Navy hydrographic engineer. Three different causes may produce such a wave, he said.

Most likely was the coincidence that several small waves, starting in as many distant storms, happened to meet crest to crest in a single spot. Again, a fast incoming tide may cause a "tide scar," or inclined wall of water at an inlet due to the friction of the bottom. And sometimes when masses of water of widely different temperature meet, a great swell or wave may be produced.

"Vacuum Bottle" Buildings

BUILDINGS and whole cities of glass are the amazing proposal of William Orr Ludlow, noted New York architect, going much farther with an idea noted in POPULAR SCIENCE MONTHLY for September.

"The use of glass," says Mr. Ludlow, "is the next logical step in the evolution of the window. There would be two shells of glass to a skyscraper, eighteen inches or so apart, leaving space to be made into at least a partial vacuum.

"I believe that it will be possible to heat and cool glass skyscrapers in the same way a vacuum bottle is used to maintain heat and cold."

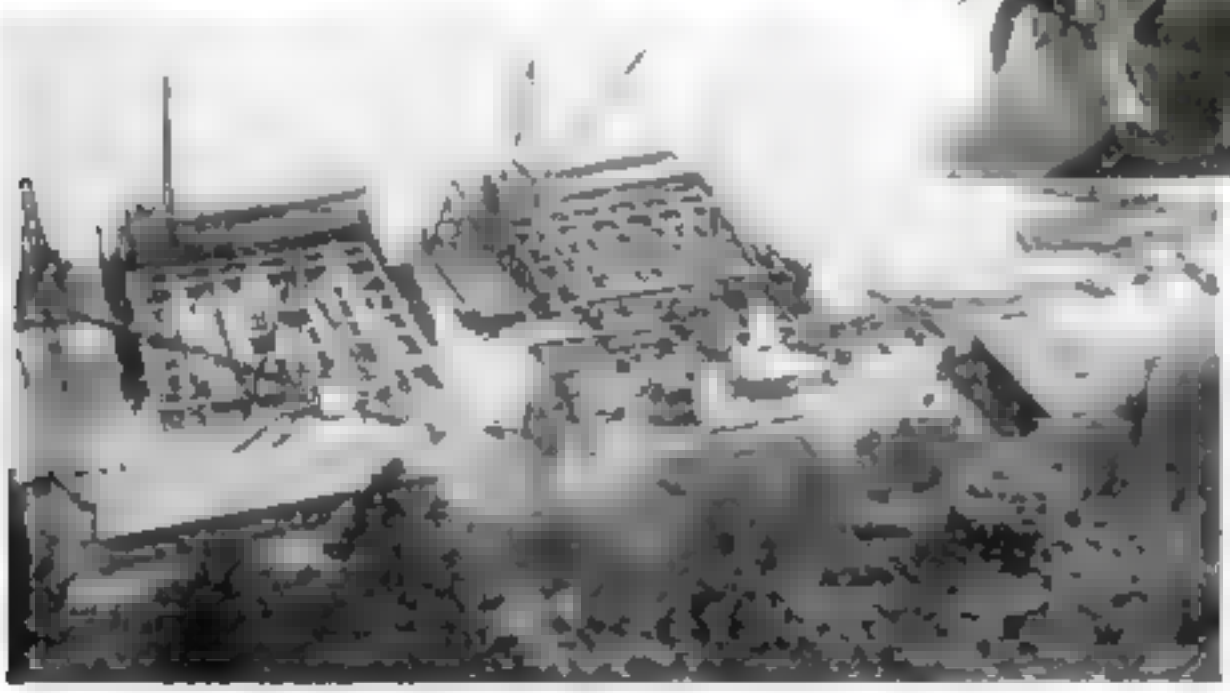
Good Airplanes Built In Many New Designs

IN WHAT direction is airplane design leading? "Scattering in all directions," says Col. V. E. Clark, chief engineer of a great airplane concern. There is no "standard" type of machine; never before have so many craft of utterly different structural and mechanical design been proving their worth.

"It would be most unfortunate for us to try to standardize at this time," says Col Clark "The longer one observes aviation the more one must realize what a tremendous amount is to be learned."

Bridging the Hudson at Last

AT LAST a mighty bridge is to span the Hudson River to connect New York City with the New Jersey shore. Amid the rattle of cranes and the puffing of steam engines, the foundations for the Jersey end of the great span are already being laid, as seen in the photograph below, beneath the shadow of the Palisades—the high cliffs that the finished highway will surmount



An airplane view of the start of construction of the Hudson River bridge in the shadow of the Palisades. The picture shows the staking on the Jersey side, across from 179th Street, New York City of the caissons in which will be built foundations for the massive piers. To form these bases for America's greatest bridge mighty cranes will pour countless tons of concrete

Race Horses with Glasses Run Faster, Tests Reveal

THE better a horse can see, the faster he can run—this was the theory recently applied by Dr. Ernest E. Emons, of Akron, O., to increase the speed of race horses. Tests that he made with special instruments and powerful lights made him sure that one horse out of every ten suffered from defective vision. Odd-shaped "specs" for racers were then tried out at Lexington, Ky.; and, it was said, the animals' time for a quarter mile was often bettered by as much as three seconds.

Although many circumstances vary a horse's speed, the average rate of animals in many tests withand without glasses convinced Doctor Emons he was right.

"Four Eyes" is not the name of this horse of the E. R. Bradley racing stable, but with his queer "specs" he reduced his time for the quarter mile nearly three seconds

Plant Punctures Tires

WAR continues against the "punct re weed" (California's expel-spreading vine whose half-inch thorns play havoc with motor car tires on country roads. The illustration shows L. S. Nevdle, chief county horticultural commissioner, with a single vine found near Los Angeles. It covered a circle fourteen feet across. Desperate efforts to check this troublesome plant's spread are hindered by its prolific seeds, 1,500 to a square foot, that mature all year round and force a continuous battle.

Census of Lightning Flashes

SOON amateur observers the world over may be asked to assist in a unique census of lightning flashes At a recent meeting of the International and Geodetic Survey in Prague, Czecho-Slovakia, experts on atmospheric electricity urged that a careful count be kept in every country An international agreement to organize the proposed study is expected Only a few weather stations and isolated observers now report on the thousands of flashes estimated to occur each minute somewhere on the earth.

Though the total amount of energy set free by lightning is known to be enormous—far greater than all the power used by man—no complete figures are obtainable.

Mystery of Blue Geese Is Solved by Science

WHEN the National Zoological Park at Washington, D. C., discovered that the eggs must be dampened before they could be hatched, zoologists had their first glimpse of baby "blue geese," winter inhabitants of the lower Mississippi Valley. For this distinguished feat, the park has just received the silver medal of the Societe Nationale d'Acclimatation, French association to promote the artificial migration of plants and animals.

Eggs had been obtained before, from captive pairs, but never hatched.

Amphibian Commuting Planes

NOW a new type of amphibian plane especially designed for the commuter is being built by a Farmingdale, N. Y., concern. Folding wings enable it to be sheltered in a boathouse sixteen feet wide. It has a speed of 120 miles an hour and a cruising range of 600 miles. Shielding devices, it is said, offer such protection from the wind that a passenger may light a cigarette as easily as in a smoking car.

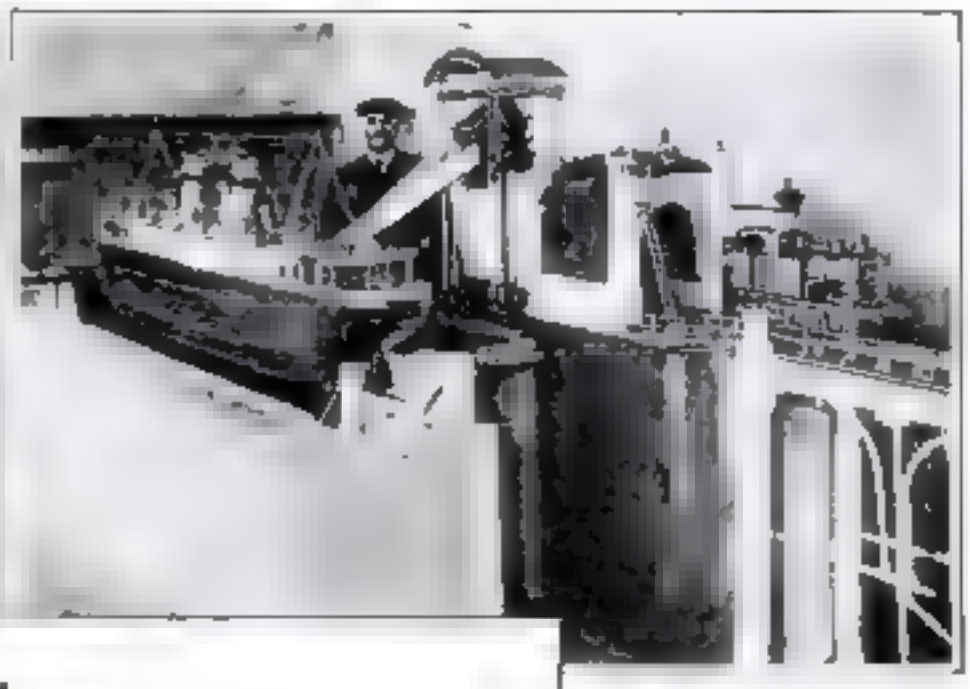
Flies Go Six Miles a Day

"TIME flies; you cannot—they go too fast," was a time-honored catch phrase, until recently the U. S Bureau of Entomology did that very thing. House flies, it found, often made a journey of five or six miles in twenty-four hours. Some 234,000 flies of different species were obtained for the unique flight tests, which were conducted in Texas.

Battle Tanks Talk by Radio

PADDED headphones and ten-foot aluminum tubing aerials that would lie down for low bridges recently made possible the first radio communication between war tanks in action. The apparatus was invented by Capt. K. E Hartley, British Territorial officer.

Hitherto the roar of the tank motors and artillery made conversation among crews difficult. With the thirty-watt transmitters and seven-tube receivers to make delicate tuning unnecessary, two tanks six miles apart talked with each other and with a base twelve miles away.



Novel Activities and Products of Original People

A Housetop Farm

On the roof of the Bur[illegible] Hotel, Providence, R. I., Duane Wescott, hotel manager, raises chickens, vegetables and flowers 400 feet above the street. Here he is shown after he caught a pigeon stealing his seeds.

Smallest Colliery

[illegible] years it has taken Tom Thomas of Wales to do the equivalent of [illegible] y shown with his best. His work, [illegible] eight years ago, in this magazine, was finished [illegible] day. The [illegible]

Ships Molded from Paper

[illegible] Kingsley, Brooklyn, shows a carpenter [illegible] how pastry [illegible] brown wrapping paper after laying on wooden ship hull [illegible]. The [illegible] paper shells serve as the hulls for miniature ship models

Rubber from Cactus Juice

Dr. John C. W. Ihmsen, Los Angeles, is shown at the left with [illegible] of rubber from cactus juice by [illegible] which he [illegible] makers a [illegible] tires and [illegible]. He points to that [illegible] will soon turn cactuses into automobile [illegible]

Chrysanthemums a Foot in Width

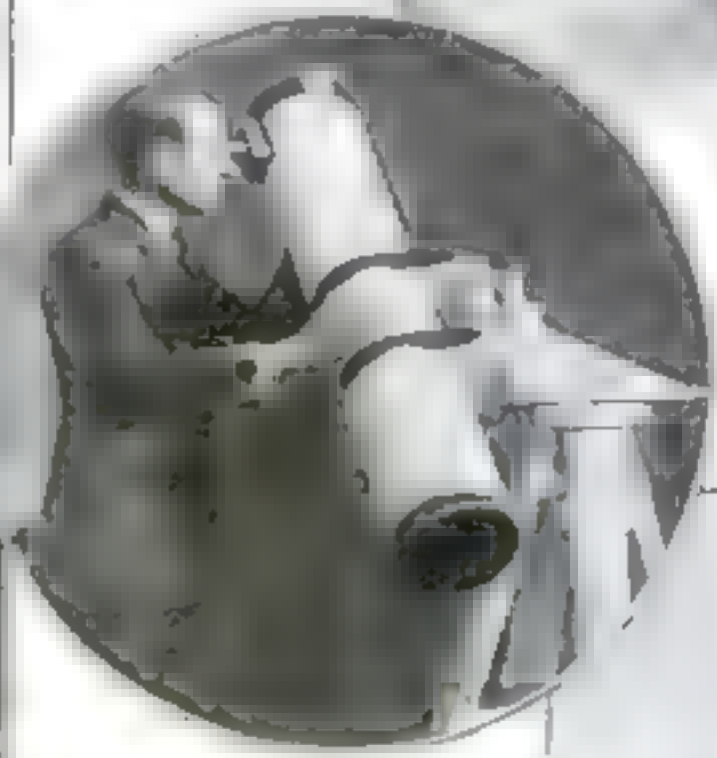
Thirty-five years of [illegible] by E. W. Burgham, Colorado Springs, Colo., developed chrysanthemums which won the national championships. On eight-foot stems, they are nearly a foot wide

The Greatest Woman Cabinetmaker

Mrs. May Gilbert, seen below in her Oakland, Calif. shop, produces rare art works in wood and directs and besides instructs a corps of men and women assistants

Seaplane Kings

These able Navy men recently set a seaplane record for endurance and speed, 1 568 miles in 10 hours, 46 minutes. Left to right, H. C. Rodd Homer Vincent and Byron Connell



Bicycle Glacier Climbing

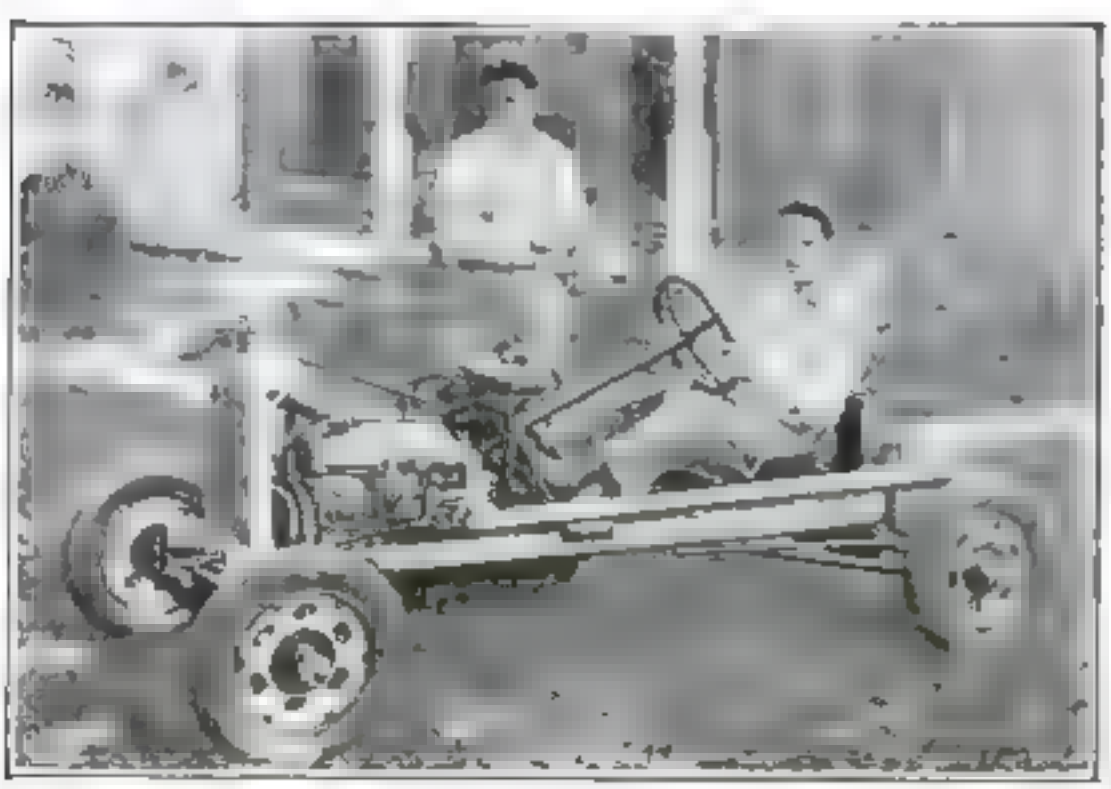
Equal to climbing the Alps on wheels was the recent feat of Russell Dudley, left, and Lawrence Steele, of Mukwonago, who on a transcontinental tour climbed Mount Rainier on bicycles. In negotiating the treacherous surface of the Nisqually Glacier they had to dismount as shown and climb with their machines across the yawning crevasses

Telescope of Plate Glass

Gilbert Leuninghoener, Fremont, Nebr., built his own telescope, grinding the ninety-power reflector from plate glass

Propeller Serves as Airplane Brake

The motor and wheels on the center of this airplane propeller vary the pitch of the blades at the flyer's will, says J. E. Carroll, inventor, photographed with the device. When the pitch is reversed, he declares, the propeller will act as a brake, landing the airplane in twice its length



Aluminum-Wheeled Car Built in Spare Time

Frank A. Doll, standing, and Edward H. Doll, of Marshall, Ill., are seen at the left with the unique motor car they built in spare time in a year. Many of the parts they cast themselves and made of the new material, such as the wheels, which are cast aluminum

Concrete House While You Wait

SOON America may have [illegible] built while you wait. [illegible] gathered at [illegible] N. Y. [illegible] pieces of "lumber" [illegible] with steel wires to form walls [illegible] said to possess the permanence [illegible] at even less than the cost [illegible] welling.

[illegible] the long T shaped planks—[illegible] two stories high—repeaters [illegible] and can be set in place in fifteen minutes.

In the March, 1927, issue of POPULAR SCIENCE MONTHLY the concrete and steel houses of European experimenters were described. In this country Herbert S. Stoneham, of New York City, and Joseph Winston, engineer, sought with the cooperation of Columbia University laboratories to develop a concrete structural material flexible, yet strong, permanent and as good-looking as brick. From elaborate tests the new "plank" of concrete came.

Concrete is mixed by a formula developed in the testing laboratories. This is reinforced by wire mesh and steel rods embedded in the concrete.

[illegible] form the outer walls. Into the bases of the T's are molded wood strips to which lath is nailed. Planks are light but strong. A 20-foot one weighs 460 pounds

A finished concrete board house at Malba, N. Y., which was erected in a few hours. The work is simplicity itself. Grooves are made in the foundation, into which the concrete boards are fitted, and then wired together

Why Hot Water Pipes Freeze First

HOT water pipes freeze quicker than the cold. Householders who are well broken in know that. But why? The pipes are usually parallel and one would think heat could resist freezing temperature better than cold.

The first laboratory demonstration of this fact, made recently at East Pittsburgh by Leon McCulloch, research engineer of the Westinghouse Electric and Manufacturing Company, has now given a scientific explanation of this seeming violation of natural laws.

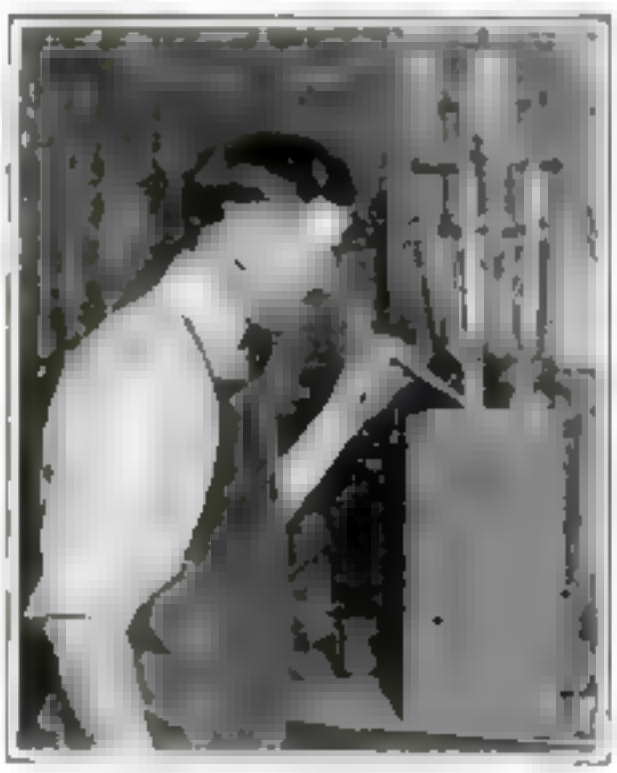
Having a possible explanation, McCulloch set up laboratory apparatus and after two weeks' intermittent work convinced himself and other workers that his theory was correct.

His new explanation is based upon the well known fact that water is densest or heaviest a few degrees above freezing. On either side of this temperature, thirty-nine degrees Fahrenheit, water is lighter. For example, at forty four degrees one quart of water weighs 945 grains and at thirty-nine degrees, 946 grains, while one quart of ice weighs only 885 grains.

A statement by McCulloch concerning his experimenting follows:

"This small change in density is enough to set up a circulation when the lighter thirty-two-degree water is at the bottom of a vessel and the heavier thirty-nine-degree water is at the top.

"Suppose we take a closed pipe filled with water and cool the lower end very slowly. When the water falls below



The laboratory apparatus that proves why hot water in a tube freezes sooner than cold, and Leon McCulloch, research engineer who made the experiment. He cooled water in one tube, kept it warm in the other and proved that the cooler liquid circulated the more

thirty nine degrees it becomes lighter than the water at thirty-nine degrees above it. The colder but lighter water rises. Thus a circulation is set up. This circulation, however, does not extend all the way up, but takes place only below that point where the water is densest, which is where the temperature is about thirty-nine degrees.

"Above this point the water remains warmer, and, since it is lighter than the colder water below, it takes no part in the circulation.

"The amount of water kept in circulation depends upon the height of the thirty-nine-degree point above the place of freezing temperature.

"In the cold pipe it will be much greater than in the warm pipe. The circulation in both pipes tends to keep the water at the bottom from freezing, since the coldest water rises and the warmer water falls. Since there is more water in circulation in the cold pipe, it is more difficult to freeze that pipe than the warmer one.

"The actual water pipes in a house are not closed at the lower end, of course, but the conditions may amount to the same thing. There is often a horizontal stretch, along a cold ceiling for example, just before the pipes pass a freezing cold space through a floor into a slightly warm room above."

How cold water avoids freezing because it circulates, due to its density below the 39-degree point, and warm water freezes in the pipe because its lightness limits its circulation

Useful Tips for Radio Enthusiasts

New Socket for A. C. Tubes

What Limits Distance? Reviving Failing Batteries

SEVERAL forms of alternating current tubes are on the market that are operated by means of a heater element that is electrically insulated from the surface which actually emits electrons. A tube of this type must necessarily have at least five terminals—two for the current to operate the heater element, one to the surface that sends out the electrons, taking the place in the radio circuit of the usual filament connection in the radio circuit, another for the grid and the remaining one for the plate connection.

Some manufacturers have solved the problem by using the conventional four-prong base and socket in which case one of the filament terminals is not used and they have added two terminals for the heater element at the top of the tube itself. This arrangement is excellent if you want to rewire an old set for alternating current operation, but if you are building a complete new receiver a neater job can be done with the alternating current heater type tube, shown in the illustration, and the use of the special five-prong socket that is specially adapted to it.

The new 227 type tube has five prongs on the base. It is designed for use on alternating current and requires a five contact socket

Emergency Battery Measures

RADIO receivers operated completely by dry cell batteries often are preferred by people who are away from home a considerable portion of the time and who consequently use their receivers only at infrequent intervals. If you go away from home for a month or two you don't have to worry about a dry-cell-operated receiver. The batteries will, of course, age somewhat while you are away, but you don't have a storage battery to send to a service station to make sure that it will be in good condition when you get back.

However, a receiver that depends on dry cells to supply the A-current is subject to one annoying trouble. The dry cell A-battery usually becomes exhausted and stops supplying sufficient current right in the middle of the program. When the music begins to weaken you turn the rheostat a bit and the music comes back to full strength. Then it begins to die out again and soon you have the rheostat full on. After that all you can do is to sit there and listen to the fading music or fight report until it disappears.

There is one emergency measure you can take to get you through the desired program. In most cases the A-current is supplied by a number of dry cells connected in series parallel. With three-volt tubes such as the 199, six cells are connected in two series of three each and the two rows are in parallel.

When you are satisfied that you can't get any more operation out of the batteries arranged in this way, disconnect one set of three and connect one of the group in series with the three cells of the other group, first making sure that the rheostat has been turned back at least halfway. The extra voltage may operate the set for as much as an hour before the voltage again drops too low to properly heat the filaments of the tube.

How to Build Your Own Electric Radio Receiver

EXPERIMENTAL work has been going on in POPULAR SCIENCE MONTHLY'S laboratory for some time in connection with the development of plans and specifications for a fully electrified radio receiver suitable for amateur construction.

Problems still remain to be solved, for we do not wish to recommend the construction of any type of receiver operating without batteries until we are positive that it will be easy to build and completely satisfactory in operation.

If you are interested in this particular problem watch for important radio constructional articles which will appear in the near future in the columns of our Home Workshop Department.

Balancing Condensers

ASIDE from material and workmanship, which are, of course, important, the electrical measurements of any type of variable condenser are the points that determine its adaptability to any particular usage. Electrically speaking, a variable condenser has only two measurements. They are the maximum and minimum capacity. If the particular capacity you desire at any given point in a radio circuit is within the limits of a given condenser, you can use it successfully regardless of its size, design or the number of plates.

You wouldn't use an ordinary tuning condenser as a balancing condenser, merely because the amount of capacity needed to balance the circuit would be below the low limit of the tuning condenser. And you couldn't use the average balancing condenser for tuning as well to the various broadcast wave lengths, for exactly the opposite reason. The maximum capacity of the balancing condenser would be far too small to effect the desired result.

What Limits Your Distance?

WHILE good tone quality combined with adequate selectivity is the ideal most sought after in radio receivers sold today and the craze for distance reception has died out to a very large extent, there still is a large demand for sets capable of bringing in distant stations. This demand comes from radio listeners situated in parts of the country where there are no local stations, or if there are local stations their programs are not worth tuning-in.

If you are in such a locality you must have a set capable of bringing in distant stations or else go without adequate radio entertainment. But no matter how much you are prepared to pay for a radio outfit that will do what you want, there are certain limits beyond which it is impossible to go even if you are a millionaire.

The limiting factor in all distance reception is static. No one has found any way to eliminate or even reduce the effect of static to any appreciable degree. In distance reception the strength of the signal in your locality will at any given moment have a certain definite relation to the amount of static. If the static level happens to be higher than the level of the signal strength, there is no known way of bringing in the distant station so that it will be worth listening to.

Increasing the power of the receiving set does not help in the slightest degree, because the static always is amplified to exactly the same degree as is the signal.

Why Can't I Obtain Tone Quality?

How You Can Tell Whether Queer Music Is Fault of Broadcasting or Your Own Set—Ways to Locate and End Trouble

By ALFRED P. LANE

In this series of links are shown the various steps that make up the chain of operations needed to bring the sounds made in the studio to your ears at home

The first step in the production of the music in the studio. This is picked up by the microphone which transforms the sounds into electrical vibrations

The next three links show the steps by which the tiny electrical impulses are magnified and transformed again into radio waves

These waves radiated from the antenna travel through space to your receiving antenna and the intervening link shows interference and fading between the two

OF ALL the thousands of radio questions we receive from readers of POPULAR SCIENCE MONTHLY, the most frequent is "Why can't I get good tone quality?" And questions about the most elusive and easily destroyed quality of any radio installation are the hardest to answer because tone quality depends on so many things. Like a chain that is only as strong as its weakest link, tone quality may break down because of weakness in any of the numerous links between the broadcast studio and your home.

Of course you can't do anything about the links that precede the arrival of the signal at your own antenna, but an understanding of what troubles may occur in those outside links may save you efforts to improve your own equipment when the trouble actually is in the broadcasting station's installation.

If, for example, tone quality seems below par some evening, it will be worth while to know with certainty that your receiver is not at fault.

All sounds, whether of a violin, a bass drum, a truck running over cobblestones or anything else, are vibrations in the air. The only differences are in the number, arrangement and relative intensity of the waves of vibrations that reach your ear. It is quite difficult to produce a sound made up entirely of vibrations at one frequency. A tuning fork under ideal conditions comes pretty close.

Your ear distinguishes the musical instruments and human voices by the relative strength of these faster vibrations, called overtones. If some overtones are lost or suppressed, you either fail to recognize the type of instrument or the tone quality seems queer and not lifelike. Of course, the more sensitive your ear and the more you have studied music the better you can appreciate true reproduction. The object of all broadcasting engineers is to convey exactly the vibrations produced in the studio, but a weakness may develop in any link of the broadcast chain.

In an orchestra in the broadcast studio each instrument is producing its own particular vibrations which are materially affected by size, shape, hangings and furniture. Formerly it was believed that all the sound that did not reach the microphone direct should be absorbed by padding on the studio walls. It was found, however, that the resultant music was lifeless because it was not natural so studios now are designed to allow a little more of the effect you get on hearing an orchestra in a large hall.

If the microphone, heart of the broadcast system, fails to pick up any particular tone frequency and turn it into equivalent electrical impulses, distortion is sure to result. From the microphone the electrical equivalent is sent to the speech amplifier and here the impulses are built up to far greater volume. By careful adjustment carried on continuously during broadcasting, slight deficiencies in the microphone may be compensated. Carelessness of the monitor, as he is called, will spoil the tone quality.

BY THE next link, the modulator, the electrical impulses are further amplified and arranged in a form suitable for impressing on the carrier wave produced by the transmitter, which forms another link. Over-modulation and under modulation produce distortion, so this step has to be constantly watched.

The transmitter pumps electrical oscillations into the antenna, where they are radiated into space. About the only chance for distortion at this link is the possible effect of near-by steel work in absorbing part of the energy of the sidebands of the wave or in reradiation that will produce similar trouble. However, this matter is gone into thoroughly dur-

ing the preliminary testing of the station, so it is not likely to crop up unless additional buildings are erected in the neighborhood.

Once the broadcast energy is radiated into space, the engineers have no further control of it nor power over your troubles.

Fading is one of these troubles. It is produced, the experts say, by two branches of the same wave being "out of step" because one has traveled farther or met greater resistance. Then, too, a radio wave that travels a great distance becomes attenuated, and the loss is mainly in the side bands that carry the higher tones of music or speech.

YOUR own antenna is the next link. So far as tone quality is concerned, practically nothing can happen to affect it. Of course, if the antenna is too low or too short or the insulation is bad you will get weak signals, but the tone will be right.

Once the signal reaches your receiver, all sorts of troubles may cause distortion. With the average five-tube set, the first two tubes amplify the signal at radio frequencies. The amplification itself cannot cause trouble, but the tubes may be working under such poor conditions that there is a strong tendency to oscillation or they may actually be oscillating all the time when the set is in operation. Neutrodynes that are not properly neutralized, coils that couple together, run down B-batteries or some other derangement may cause this trouble and the tone quality suffers because the signal is distorted.

After the signal is amplified by the radio-frequency amplifier tubes it is fed into the detector—the next link. Here other forms of distortion may creep in. The tube may be overloaded in an attempt to get more volume. The grid leak may be of the wrong value. The plate voltage may be too high or too low.

THE detector tube rectifies the wave and passes on the frequencies within the audio range to the first stage of audio amplification. Here the quality of the audio transformer is most important. It should amplify all audio tones evenly and to the same extent. If it does and the tube is in good condition and is working with correct B and C voltages, the signal will pass amplified but otherwise practically unchanged to the last audio stage of the power amplifier. Of course, the audio transformer that operates the second stage in your set or the similar unit in the power amplifier must be capable of amplifying uniformly, and the power tube must be in good condition and supplied with correct B and C voltages.

Tone quality is not dependent on the use of your power tube. You can get perfect tone quality out of the ordinary 201A tube used in the last audio stage, but hardly enough volume to be properly heard in a small room. All the power tubes do is to boost the volume and keep the tone quality right. You can't do that with the 201A tube, for the minute you try for volume worth listening to distortion creeps in, because the tube is overloaded. If you want volume with perfect tone quality you must use a power tube.

Naturally the loudspeaker is a most important link. It takes the electrical impulses fed into it by the audio amplifier or power amplifier and converts them into air vibrations that you can hear. It has no tone of its own and it can be accounted as perfect only if it reproduces accurately the electrical impulses in the form of sound waves without adding or subtracting anything on its own account. The terms "mellow," "beautiful tone," and so on, are meaningless as applied to loudspeakers.

Some distortion may be introduced after the sounds are transmitted to the air in your room. The shape of the room, the hangings on the walls and the position of the loudspeaker are important. If you get the wrong combination some delicate overtones may be lost or an echo effect may spoil the music.

The reception of the sound waves by your ears completes the chain.

If tone quality seems bad when you are receiving from one station, tune in some other stations. Good tone quality on several of them will be a pretty sure indication that your equipment is not to blame. But when all the stations sound wrong you may be sure that your own equipment is at fault.

Discovering the source of the distortion in your apparatus can best be done by a process of elimination. Since detector tube distortion is not likely to be severe as compared with troubles in the radio-frequency or audio-frequency end of the set, tune-in the nearest broadcast station and try cutting out the radio-frequency and audio-frequency stages, one at a time, until you locate the trouble. If the local station is powerful you can cut out the entire radio-frequency amplifier system by winding a coil of about ten turns, taking the radio-frequency tubes out of the sockets, connecting the ends of the coil you have wound to the antenna and ground wires and holding the coil near the detector tuning coil. If the tone quality under such conditions is much better, find out what is causing the trouble in the radio amplifier stages.

Connecting headphones in place of the first audio transformer will tell you if there is anything wrong with the audio amplifier, because the audio end should give as good tone quality as you ordinarily hear on the headphones from the detector.

Determining whether the loudspeaker is good is not so easy. Trying several speakers is about the only method possible for the amateur radio fan. This may take time and effort but that is also true of many worth while things.

Distortion that will spoil accurate tone reproduction may be produced in any of the radio links shown on this page

While the signal is still in the electrical form it may be distorted in the radio frequency amplifier, in the detector or in the audio amplifier

The loudspeaker itself may not accurately convert the electrical impulses into sound waves and the location or hangings in the room may also cause trouble

A neat and effective scissors sharpener can be kept on the sewing table without getting in the way. It is provided with a guide that is adjustable so the blades can be run over the stone at an effective angle

A new brush for renovating your furs has "bristles" made of "silk wire" set at an angle, amounting to a series of combs. These gently and gradually penetrate into hair and remove dirt quickly and effectively

New Household Utilities

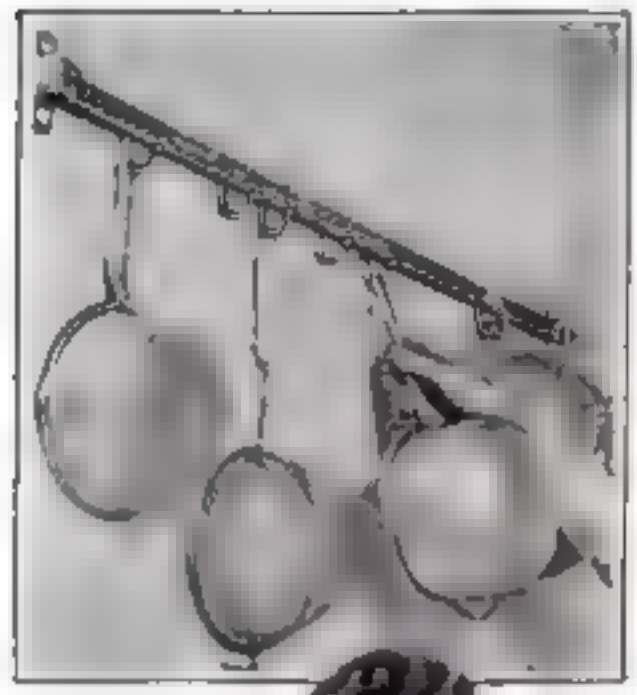
There is a floor lamp that has a shade on a swivel and so enables you to [illegible] with them. For reading at [illegible] It gives adjustable [illegible] person using it and others from the normal glare

[illegible] such other and the meshes will move no farther

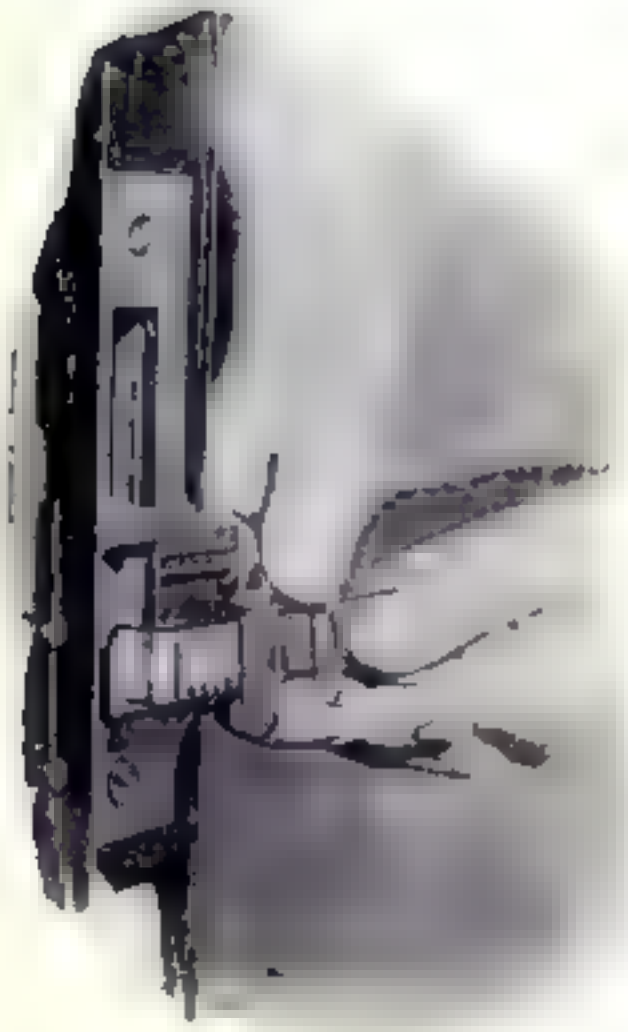
You will not have to search around the bottom of the bathtub for lost soap when you use this rubber container that floats safely and retains the cake securely no matter how much you splash. The unique device comes in all colors so you may select what goes best with the regular bathroom decorations

Here is a can opener that is said to make cut fingers an impossibility. The hard metal point sinks into the edge of the can, then ratchetlike teeth pull it around and the cover, a perfect disk, is lifted out, leaving no sharp edges on the container

Here is a novel bed invented in Germany for invalids and persons who don't like to get up for breakfast. It is somewhat like a barber or beauty parlor chair. The bottom bends down and the top up. A table moves with the mechanism, so that it is always conveniently near you

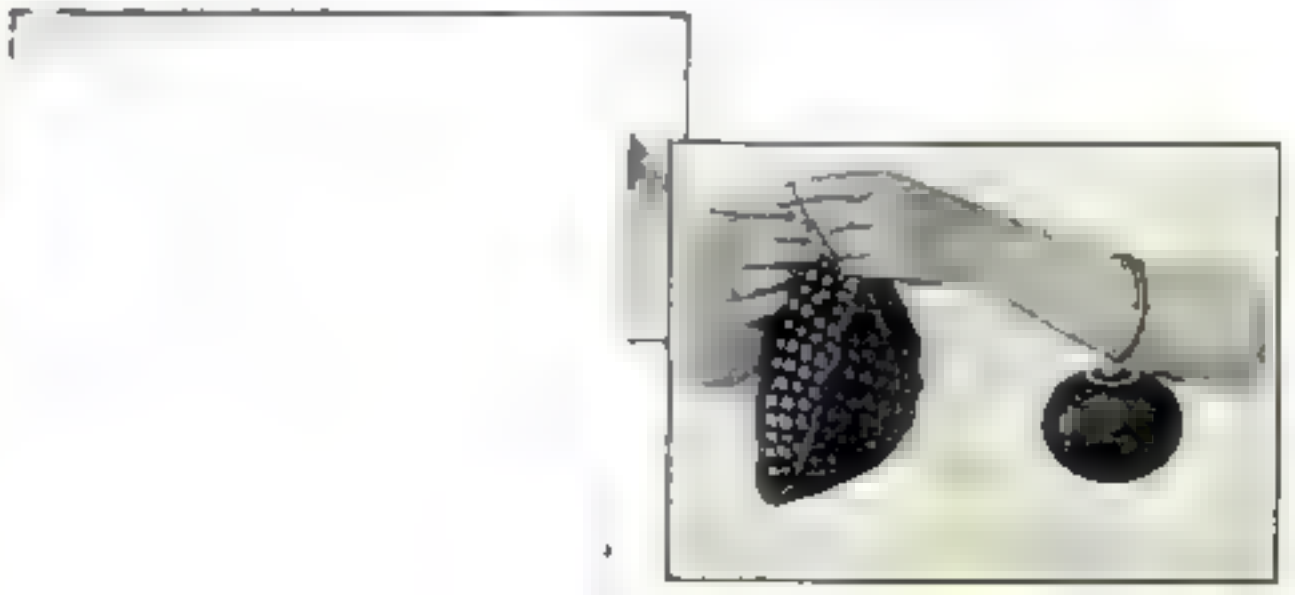


clever device for saving space in kitchen. The rail is equipped with hooks for pots and pans that slide to any position, so small articles can go close together. When you wish to remove it the loosening of thumb screws at the ends makes that process very simple. It is put back just as easily



No more candles dropping out of the sticks or falling out of plumb. Soft rubber sockets fit into the sticks and around the ends of the candles, holding them in their place quite firmly

This steamer and boiler has a double bottom that is easily cleaned and also makes it possible to cook things without danger of burning. Set one way, it keeps food above water and turned the other it lets them boil



Here is a metal guard that slips over the latch before you close the door. After it is closed another guard slides down and holds it in place so no burglar's jimmy can operate on the latch. It has also a hole that enables you to lock it on a closet door of a hotel room, thus guarding your property against theft when traveling

Mental H… …am Loyd

Give You … Workout

Six Puzzl… …Brain

PUZZLES that have more than an amusement value, because they train the mind to think fast and straight, are presented on this page each month by Sam Loyd, the world's foremost puzzle maker. They show conclusively that a puzzle can be fun without being nonsense. See how quickly you can answer the problems given. Then turn to page 141 to find the correct answers and the time allowed for obtaining them, and see if your mental machinery is in trim.

Alphabetical Arithmetic

THE letters of a certain word were numbered consecutively—1, 2, 3, 4, 5, 6, 7, 8, 9 and 0. Then a two-column sum was arranged wherein the ten digits were each represented once, and the correct total set down.

In our sketch the thirteen figures in that sum and total have been translated into the ten letters of our word in keeping with their assigned numerical value.

Now we are required to substitute figures for the letters. It is a test of one's ingenuity in word construction rather than an arithmetical exercise. If you work out the answer, which you can find by turning to page 141, in the time allowed you will show rare aptitude.

Finding a Hidden Science

IN THEIR given order write down words to fit the following definitions.

Toss.

Leave one country to settle in another

Battle.

A larder

Now if the line is composed of the correct words, you can strike out of them words to fit the following definitions:

A cavity in the ground.

A fireplace.

Abundant.

Breathe laboriously.

The remaining letters, in the regular order, will spell the name of an important science.

This test of one's readiness with words may call for twenty minutes' time.

You will find this no easy problem, but if you can solve it you can congratulate yourself on your alertness of mind. See what you can do. The correct answer and the reasonable time to work it out are given on page 141

…ap…
…wh… …buy
one t…

"No, … baby has no teeth an… …not eat an apple. You give me one of your pennies and then you and I can each buy an orange and baby can watch us eat them."

How many pennies did the children have?

This little exercise in mental arithmetic should not require a great deal of your time. Turn to page 141 for the correct answer and the time allowed for solving.

A Roman Mob

AN OLD-TIME stage manager was telling of his ingenious method of producing a Roman mob scene by marching a handful of supernumeraries around the back "drop."

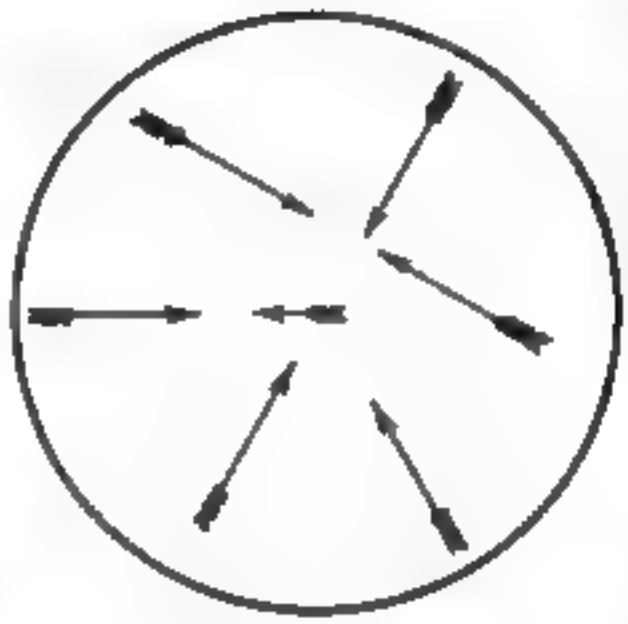
"How many were in the circle?" we inquired. "I don't recall exactly," he replied, "but I was in the procession, and four fifths of those ahead of me added to one quarter of those behind me equaled our total number."

From his statement we are to figure out how many men constituted that Roman mob.

Try your mathematical perspicacity on this, then see on page 141 the correct answer and the time allowed to find it.

Puzzling Criss Cross

…ured to draw three straight …m the circle pictured below, …ace seven separate inclosures, …e containing one arrow. …' corral those seven arrows …nce construction calls for …d accurate judgment with …tance, angles and align… …u can find the solution as … 141 in the time allotment



Dissecting the Moon

WE ALL know now that the moon isn't really made of green cheese, and anyone who thought such a thing would be quite properly laughed at, but for the sake of a problem let us suppose that it is and that it is really crescent shaped as it appears in the picture. Into how many pieces can that crescent cheese be cut by four straight slashes with a knife?

We are asked to draw four straight lines across the rectangle, the lines being criss crossed in such a manner as to produce the maximum possible number of segments within the crescent. Any four lines would produce a considerable number of pieces, but the problem demands the four lines that produce the greatest possible number. Here is a hard test of your abilities. To find the correct solution and the time you should require to reach it turn to page 141.

Sam Loyd has prepared another set of his fascinating new test puzzles which will appear in next month's issue of POPULAR SCIENCE MONTHLY.

Build for Your Wife, But—

Don't Let Her Waste Money and Destroy Beauty by Changing Your House Plans During Construction

By JOHN R. McMAHON

"HOW much is our house going to cost, George?" asked his little wife one evening.

"Exactly seven thousand, five hundred dollars," replied the young man, looking up from a sheet of paper crowded with penciled figures. "And that figure includes everything down to a toothbrush holder in the bathroom."

"You have a wonderful head for arithmetic, dear," said Dora admiringly. "Some day you may become Director of the Budget—you know, at Washington—and save the Government lots of money."

"I don't claim to be a wizard," George expanded his chest a trifle and gave her an indulgent smile. "The main thing in keeping down the cost of building is to figure everything out to a dot and then don't change plans. That's us."

"Oh, George, that reminds me! I saw that model house up on the hill today and we simply must change our plans a teeny bit. That house has a better looking entrance than ours and it has the cutest, most convenient near-hall between the living room and kitchen."

"We agreed not to change," grumbled the young husband. "Still, I don't like our entrance myself, and since we haven't actually begun to build, I guess that cut-rate architect wouldn't charge much to fix up the blueprints."

Expensive alterations in plans after house building is under way may be avoided by making cardboard models which show the home as it will appear. These are particularly helpful to those who cannot "read" blueprints. Models such as that in this picture are built at from $35 to $150 by experts in the art

THE name of the cut-rate architect was Delancey Jones, and he truthfully claimed descent from a line of robber barons. Why, he had the nerve to charge $30 for the change in design while saying that this was a nominal fee without profit. He argued that $4 an hour was the lowest legitimate rate for an architect's service and he was only charging $3.50 plus cost of linen, paper and sundries. George and Delancey had quite a discussion about cut rates, inheritance from robber barons and the density of home owners who think that brain work expended on a dwelling is a total loss. The net result was that George revised the estimated cost of his house to $7,550.

"Anyhow, we're through with Delancey," said the young man, "and the builder won't try to gouge us. He is a plain chap with an honest name, Wilbur South. He has about as much use for architects as I have. He says more than half the houses in America are built without any architects around and don't they look it? That is, they're just as good as the other kind. A regular builder doesn't bother much with plans. He is like a good piano player who just sits down and plays anything you want by ear. Of course Wilbur can figure, and he is just now figuring out just how much extra those changes are going to cost."

Wilbur presented an amended bid which raised the total for the house to $7,678.43.

"Oh, what a lot of extra money!" exclaimed Dora. "And do you think that forty-three cents looks natural, George?"

"That," glumly stated the husband, "shows close figuring. All the big corporations make their financial reports down to a few cents. Wilbur is honest. But this is positively our last change. The work starts tomorrow and I want to serve notice on you, Dora—"

"Perhaps I'll serve notice on you, George," sweetly rejoined the young woman.

It happened that Dora was right. George decided to alter the location of the built-in garage after the cellar walls of concrete had been poured. About fifteen feet of wall had to be demolished and rebuilt, not to mention consequent changes above. It was really a worth while improvement and the broken up concrete was not all wasted, George said, because it came in handy for fire-stopping. Wilbur was reasonable. The cost of the house was increased to $7,782.09.

AFTER that there were quite a few minor and a couple of major alterations. Wilbur said he couldn't find time to bill all the extras as they occurred but would keep track of them and put in a fair charge at the end.

Dora received some gift furniture from relatives, mahogany and walnut. In order to make it fit in the house one partition and two windows had to be shifted. It would have been cheaper to buy new furniture but the gift pieces were handsome and also had a sentimental value. The open fireplace and mantel had to be changed to harmonize with a scheme of decoration recommended by an artist. The kitchen required alteration so that a new style electric refrigerator would fit in an alcove. A side porch was extended by several feet. Venetian window blinds, bought and paid for, did not look well in place and were thrown in the discard.

When the young couple moved into their house its cost had risen over a thousand dollars above the original estimate and stood at $8,896.32. Wilbur had all the extras neatly itemized. He had done the

Building Queries Answered

READERS should feel free to ask the advice of Mr. McMahon in any problems they may encounter in building homes and to ask further information concerning any subjects or details discussed in his articles. Letters should be addressed to John R. McMahon, Housebuilding Department, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

best he could, charging so little that he almost lost money on the whole job.

George and Dora typify many thousands of home makers in America. Shall we laugh at their comic errors or sympathize with them in their misfortune? Shall we use this case as a text for a rousing sermon on the use of an architect in the planning of your home, and the advantages of foresight in building?

Much to the surprise of the average reader and myself, who are equally inclined to lecture and uplift, an eminent authority says that it is futile to seek a moral in the tale of George and Dora. They went wrong, but so did Adam and Eve, and so will the majority of home builders as long as the world lasts. In truth, it is human nature to change plans and make mistakes.

Listen to Ernest Flagg, nationally known architect of the Singer Building and creator of the Flagg small house

"There is no argument as to the great waste and loss involved in changing plans, especially after construction of a building has started," he told me. "What can be done about it? Practically nothing. It has always happened and always will. There is indeed one way out of it, which forms a rare exception to the general rule. That is when a client accepts the architect's design, then goes away and comes back only when the house is finished. The client does not visit the site, sees nothing and knows nothing of the building process.

"This was the method followed by Charles Scribner, the publisher—the most intelligent man I ever met—when he commissioned me to do his house. He saw the house for the first time on the day when it was completed and he was moving into it. And he was entirely satisfied."

These pictures show how changes decided on during construction can alter an architect's original conception of a house. The upper picture is an architect's drawing of a pretty and well designed though not elaborate home. Below is a photograph of the house built from the architect's plans. Why does the one look so much more attractive than the other? In the first place, the bonds were omitted. More important, the building was perched on too high a foundation. Most important, the extra dormer built between the original ones destroys the symmetry of the structure

"SUPPOSE you were building a house for yourself, Mr. Flagg?" I asked.

"I would do like everybody else,' was the frank reply. The noted architect smiled a little, toying with a paper knife as he sat in the high-ceilinged and sparingly decorated consultation room of his New York office. "I would find plenty of things that I'd want different as the job progressed.'

"More study of plans in advance has been offered as a remedy," I suggested.

'That sounds reasonable to some persons, but it is not effective. More understanding of plans by clients simply intensifies the trouble. The more they know the better they grasp the possibilities of change.'

"Does the architect as well as the client lose by changes?'

"Yes, very often. I am undertaking a job for a New York hospital and the numerous shifts from the original design have already eaten up all my fees in advance. I might charge for this extra service, but do not like to do so. Nobody in particular seems to be responsible."

"You do not approve mere fickleness on the part of home builders?"

"No. There is one kind of changing that is entirely inexcusable. That is when a man has a good plan done by a competent architect and he listens to advice on modifying it by any Tom, Dick or Harry who comes along. Something like this happened to one of my small houses in New England, a case where I did not supervise execution and the owner was receptive to miscellaneous advice. Afterward he wrote me that the alterations from the original plan had been a great mistake."

"Do contractors take advantage of people's weakness for plan changing and charge unfairly for 'extras'?" I asked.

"Many of them certainly do," replied Mr. Flagg. "There is protection against such gouging on large or expensive dwellings where the architect puts a unit cost clause in the specifications. This is what I do, and when a change is wanted I do not ask the contractor what the price will be, but tell him what he may charge on the unit cost basis. But this protective measure involves expensive figuring and is never found in the ordinary small contract."

According to the associates of Alexander B. Trowbridge, who used to plan many dwellings in the metropolitan suburbs, the annoyance of continually revising finished designs, and even structures, was one of the reasons which impelled him to leave this field. Mr. Trowbridge is now a consulting architect, who does business largely with his fellow professionals. He is also architectural adviser to the Federal Reserve Bank system.

"Contractors on city cooperative apartments often take jobs at cost," I was told by G. Gallico of the staff of Andrew J. Thomas. "They figure that they will make enough profit on alterations desired by tenants—moving partitions, redecorating and whatnot. One woman tenant paid $4,000 for an apartment and spent as much again for changes. One of the biggest items of added expense is an extra bathroom at a point remote from the original plumbing system, which causes duplicate piping throughout. Incidentally, I believe the high cost of modern building is due largely to a demand for luxurious bathrooms, three of them in a house where one was, to serve.

THE inability of most persons to read or understand plans is a leading factor in changes during construction, according to Carl F. Grieshaber, of Delano and Aldrich, which firm designed a house for John D. Rockefeller, Sr.

"Cannot plans be simplified for laymen?" I asked. "That is, by omitting the numerous lines and figures that are useful only to builders?"

"We do so in sketches which are preliminary to the working drawings," replied Mr. Grieshaber. "Sometimes we have models made so that the client can visualize the appearance of his house. It is rare that a model shows the interior. A fancy exterior model, say three feet long, costs around $350. It is usually built of cardboard with celluloid windows. A less expensive model, costing around $85, may be put together from the architect's sketches. A house embodies many complexities of line, proportion, color and setting, and a model tends to give us a clarified complete view of the enterprise. The architect often resorts to models of small details, such as a certain style of molding. He studies this sample or experimental section and decides whether to embody it in the final design.

"What about the cost of changing plans?"

"Architects

(Continued on page 163)

"Your Car Need Never Freeze"

Gus Tells of the Best Mixtures to Use in the Radiator and Gives Tips on Winter Motoring

By MARTIN BUNN

"GOT plenty of alcohol in your radiator?" Joe Clark inquired of his customer as he cranked the gasoline pump in front of the Model Garage. "Pretty cold today—better let me test it, anyway."

"You keep away from that radiator," Tom Madden objected. "No more expensive alcohol for me! I've got a trick worth two of that. You won't see me wasting any more money on alcohol for any automobile radiator. And what I'm using won't boil away or evaporate like alcohol."

Gus Wilson, Joe's partner in the Model Garage, drove up in his car just in time to overhear Madden's statement.

"So you've worked out something real new," said the veteran auto mechanic. "How long have you been using it?"

"Nearly two weeks now," replied Madden. "It sure works fine. Maybe I'll tell you what it is some day if you're real good!" he called back as he drove off.

Joe was impressed. "Must be good if he can get by with it in this weather," he exclaimed. "It's been cold enough to freeze a brass monkey all this week. What do you suppose it is?"

"I don't suppose—I know—didn't I smell it?" Gus grunted. "He only thinks he's found something new. I'll bet he'll be singing out of the other side of his mouth before long!"

"BUT what is he using?" Joe asked as Gus opened the big garage doors.

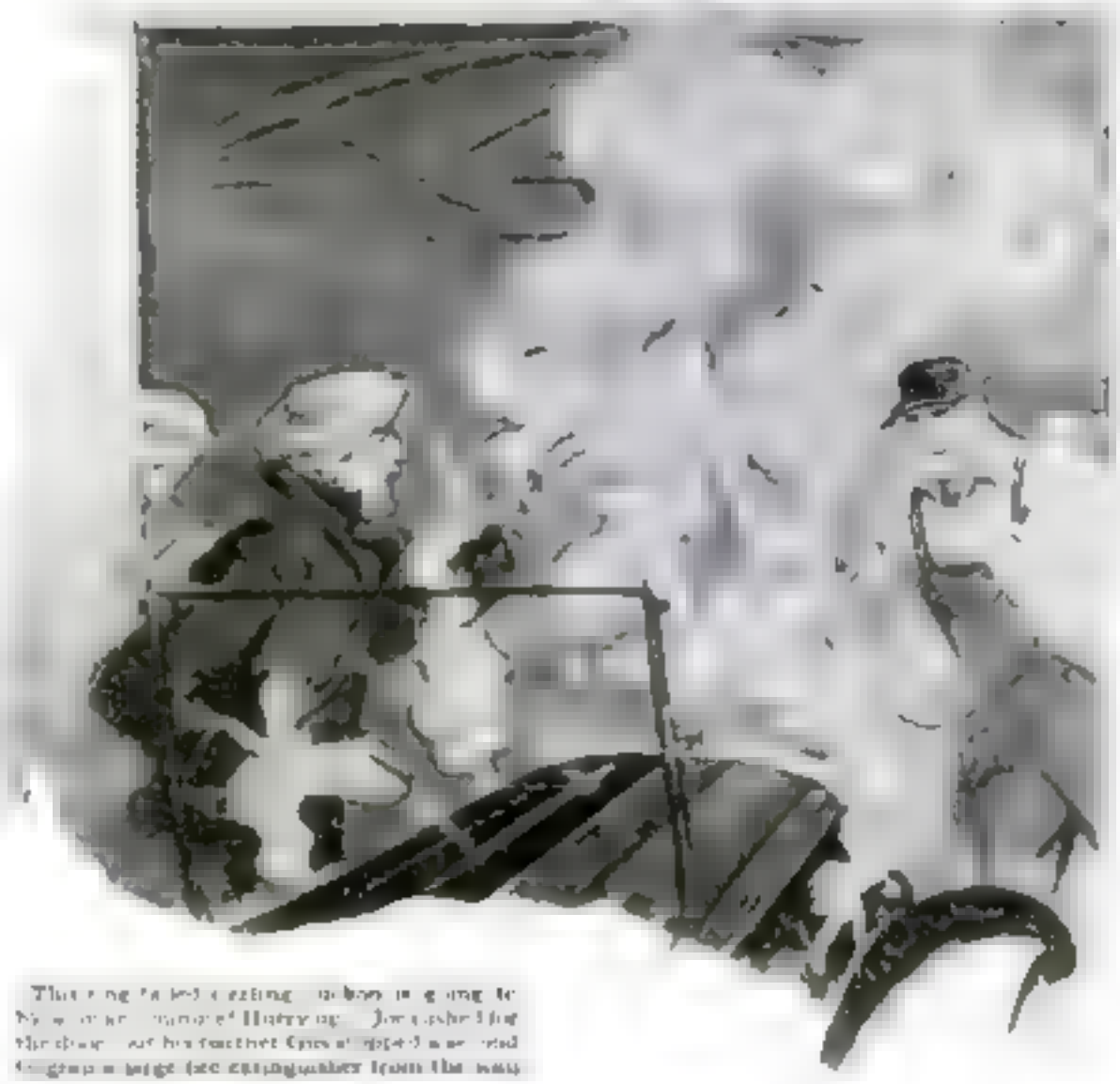
"Humph!" growled Gus, "it's a good thing you aren't as dumb as you seem sometimes. You must have a cold if you couldn't smell what he had in the radiator."

It was two days later that Gus, at work on a car, and Joe, engaged on the books in the office, were startled by a tremendous clatter outside the garage followed by a flow of distinctly forceful language.

"Hey! Open your dod-gasted door and let me in, will you?" roared an impatient voice. "This ring-tailed sizzling cuckoo is going to blow up any minute! Hurry up!"

Joe rushed for the door, but Gus stopped a second to grab a large fire extinguisher from the wall.

"It's Madden back again," muttered Gus, and as Joe swung the door open Madden was dimly visible through a



This ring-tailed sizzling cuckoo is going to blow up any minute! Hurry up!" Joe rushed for the door, but his partner, Gus, stopped a second to grab a large fire extinguisher from the wall

cloud of blue smoke that smelled overpoweringly of kerosene. Just then the motor gave a peculiar, squeaking grunt and stalled.

"That marvelous new antifreeze solution isn't so good after all, is it?" observed Gus with a sarcastic smile as he replaced the fire extinguisher, now that the motor had stopped and the danger of a fire was past.

"You said it," admitted Madden glumly. "Kerosene may be good for lamps, but it sure is punk as a radiator filler in place of water. Just look at this car! The upper hose connection busted and now the dinged stuff is all over the place. What made it work so rotten all of a sudden? It's worked fine up to now."

"You must have been doing some hill climbing," suggested Gus, and the other nodded in assent.

"KEROSENE is no good to cool a motor when it's really working hard," said Gus. "It doesn't carry away the heat as water does. Besides, kerosene rots rubber double quick—especially when it's hot. The boiling point of kerosene is way higher than is good for the ordinary auto motor. Kerosene is all right if you only drive slow for short trips. Lots of fellows use it if they only drive down to the station and back or to the factory where they work—sort of light taxi service, you might say."

"Doesn't it rot the hose connections when you use it like that?" Madden asked.

"Sure it does," replied Gus, "but if you put in new hose connections right at the beginning of winter and smear the inside of the hose with thick shellac and leave the radiator empty overnight so the shellac gets a chance to set, usually the hose connections will last out the winter.

"You want to remember not to use any radiator cover with kerosene in the radiator. All the cooling surface you've got is none too much, because the kerosene doesn't soak up the heat from the cylinders and carry it to the radiator more than about half as well as water."

"Don't worry!" interrupted Madden. "No more kerosene for me! Get busy and fix whatever made the motor stick and put in new hose connections. Then I'll be a good little boy and fill it up with alcohol as Joe suggested."

"Fixing the motor may be easier than you think," Gus said with a smile. He stepped in the car and the motor turned over and started at the first pressure on the starter pedal.

"Well I'll be blasted!" gasped Madden. "What did you do, hypnotize it, Gus?"

"I didn't have to." Gus answered as he shut off the motor and rummaged under the front seat for the starting crank. He turned the motor over several times to test the compression and then put the crank

(Continued on page 137)

Ingenious Kinks *for* Your Car

Exhaust Melts Windshield Ice — Water Pumps Tires — Secret Ignition Switch — Other Ideas

IN LOCALITIES where the water supply is delivered to your home at a pressure of fifty or sixty pounds you can arrange to let the water pressure do the work of pumping up your tires. All you need is an old water tank, the larger the better, and a few pieces of piping. Fig. 1 shows how the tank should be set up. Assuming that the tank is empty when the water is allowed to flow in at the bottom from the supply pipe, the air in the tank soon is compressed until it equals the water pressure. If you attach the air hose to your tire valve the compressed air flows into your tire as the water rises in the tank. The float valve is needed only to prevent water being forced into the tire when the air in the tank is all used up. To put the tank in condition for another series of pumpings shut the supply valve and open the drain cock. This allows the water to flow out of the tank and a fresh supply of air rushes in by way of the air hose. Since some pressure is required to overcome the valve spring, you cannot pump a tire up to a pressure exactly equivalent to the water pressure.

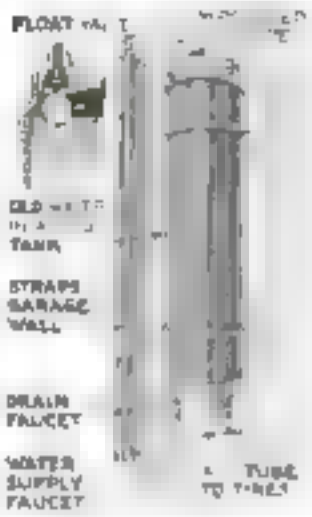


Fig. 1. You can use an old hot water tank, piped as shown, to give you air pressure for pumping your tires.

Ten Dollars for an Idea!

HAROLD NOWELL WHITMORE, of Oak Park, Ill., wins the $10 prize this month for his suggestion of a windshield ice-clearing device (Fig. 2). POPULAR SCIENCE MONTHLY awards $10 each month, in addition to regular space rates, to the reader sending in the best idea for motorists. Other contributions used are paid for at the usual rates.

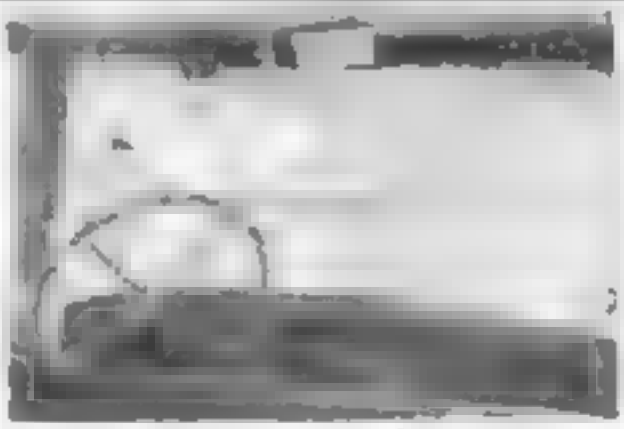


Fig. 2. When sleet or snow begins to stick you need a windshield heater to make driving safe. As shown in this illustration, the windshield is heated by hot air supplied by a special exhaust pipe stove and old vacuum cleaner parts.

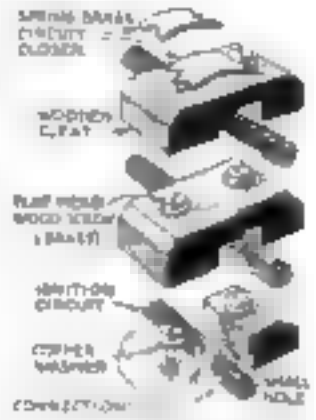


Fig. 4. The particular merit of this secret switch is that it need not be hidden from view. It does not look the part.

piece of hard wood. Drill the holes for the two screws and carve a groove for each wire end from the center notch to the screw hole. Then enlarge the screw holes just enough so that small loops can be turned in the ends of the wires and placed in these holes. Use flathead wood screws with copper washers and figure out the size of the enlargement at the bottom of each hole so that when the screw is forced down tight, each wire end will be jammed between the side of the hole and the screw so as to get a good electron contact. A piece of spring brass cut to wrap under the edges of the flathead screws will complete the connection between the wire ends. Of course round-headed screws would ordinarily be used but anyone ordering the flathead screws is most unlikely to attach particular significance to them. If you install this switch in an old car, dirty the cleat to make it look old.

Several convenient locations for the concealed switch will suggest themselves. Check up the location of the wire running from the timer to the dash switch and then choose the easiest location to get at.

Fighting Snow on Windshields

NO WIPER will keep your windshield clear when snow freezes to everything it touches. Then you must apply heat to melt the snow. Fig. 2 shows a homemade hot air heater applied to the exhaust pipe. A funnel arrangement with the opening toward the fan forces air through the stove, up an old vacuum cleaner hose and out the nozzle, also a vacuum cleaner part. The air keeps the glass above the freezing point, enabling the wiper to work. Some experimenting will get the nozzle the right distance from the glass.

Cures Sagging Garage Doors

GARAGE doors, because they are large and heavy, often give trouble. They sag and stick and the pounding required to open them loosens up the hinges and aggravates the trouble. Fig. 3 shows a simple way to brace the door so that there will be less tendency to sag. Metal bars with a cross section measuring ¼ by 1 inch are bolted to each door as shown. Aside from stiffening the whole door, these bars transfer the weight to the point best able to bear it — the lower hinge. If the metal bars are not easily obtainable, nearly as good results can be got with boards.

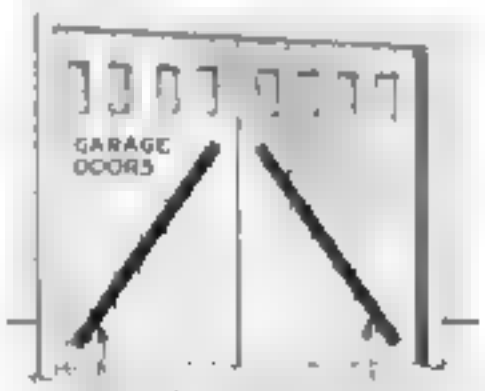


Fig. 3. Metal bar braces bolted to your garage doors, as shown, reinforce the doors and prevent their sagging.

Novel Secret Switch

THE value of any secret ignition switch depends on how cleverly it is concealed. The switch shown in Fig. 4 is so constructed that it doesn't look like a switch and can be placed in plain sight if necessary. No one would suspect the wire cleat of harboring a concealed break in the wiring. The cleat can be cut from any

Weatherstripping Your Garage

SECTIONS of old inner tubes tacked along the lower edge of the garage door will help keep the garage warm and prevent fine snow from being blown under the door. Be careful that the tube projects only far enough below the edge to make contact with the ground. If it hangs too far it may get caught and jam the door when it is closed. If the doors fit too loose at top and sides additional sections of inner tube can be nailed to the frame so that the doors will press against them when they are closed.

Doors thus made air-tight will keep the car clean longer after each washing, as they exclude dust.

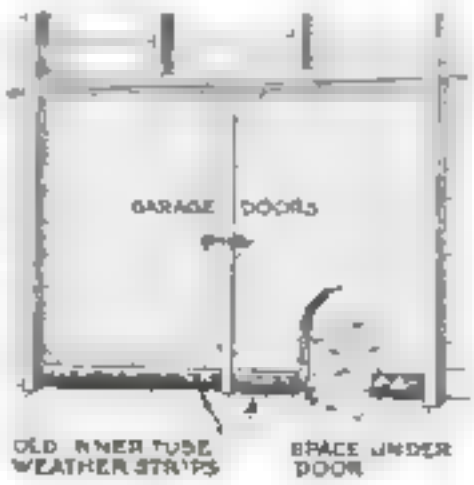
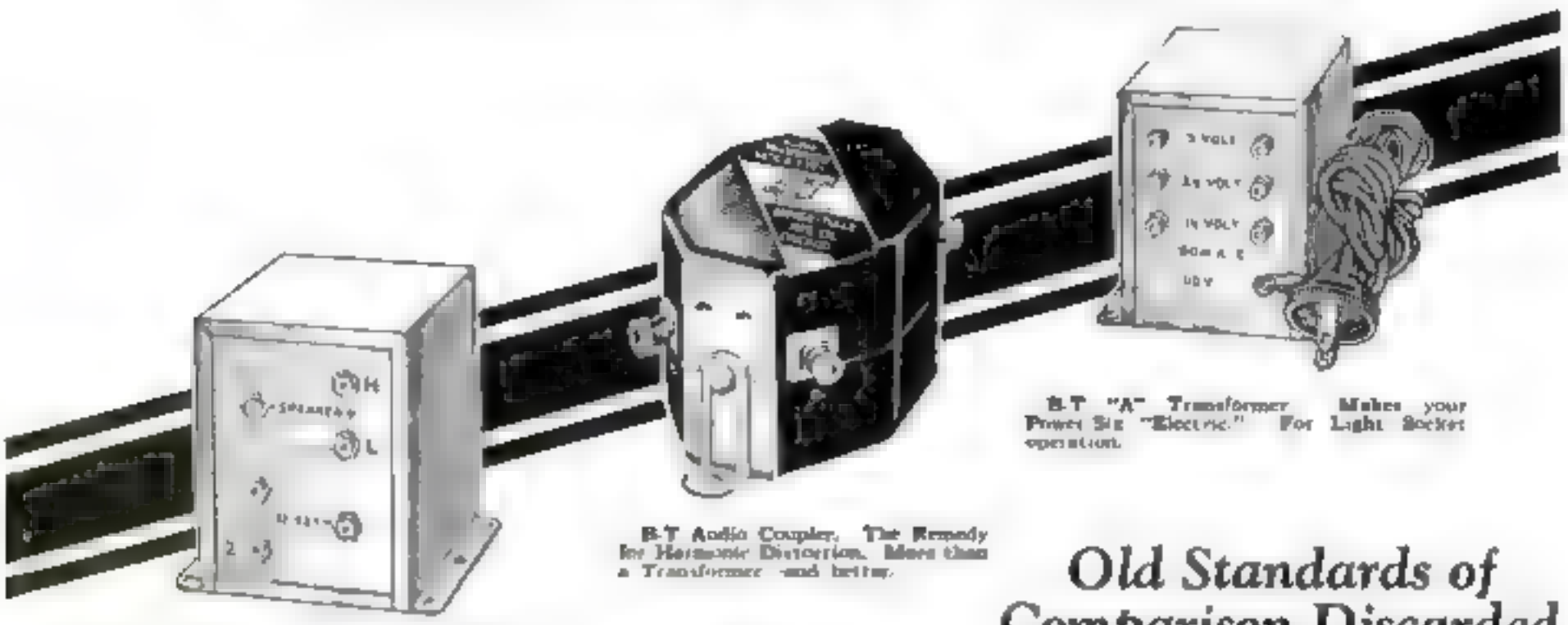


Fig. 5. How sections of old inner tubes weather-strip garage doors.

New Bremer-Tully Products Command Attention



B-T Speaker Coupler. For tone quality and increased volume. Protects Speaker and prolongs its life.

B-T Audio Coupler. The Remedy for Harmonic Distortion. More than a Transformer—and better.

B-T "A" Transformer. Makes your Power Six "Electric." For Light Socket operation.

Old Standards of Comparison Discarded

Bremer-Tully have just released a new product which they believe will create world wide discussion.

It is the result of discarding the old idea of "Amplification Curves" generally used as a basis for comparison in audio transformers.

B-T have attacked this problem from an entirely new standpoint—that of "Harmonic Distortion."

B-T believes the Audio Coupler they have designed along these lines is a very wonderful advance in reproduction. Space does not allow full explanation here. It will be found, however, in the B-T Booklet, "Better Tuning." See coupon below

The Audio Coupler is more than a Transformer. It is designed with constant impedance core, and a Tertiary loading coil. Those who know Bremer-Tully's standing appreciate that they could not release such product if they did not believe it superior

There are two types. The 3-31 is for first stage. The 2-22 is for second stage, or for all three stages, where three stages are used. This is particularly useful in replacing three stage Resistance Coupled Amplifiers.

Bring your old set up-to-date by replacing ordinary transformers with new B-T Audio Couplers. Be sure to use them in your new set.

Price, either type $6.00.

BT

The Speaker Coupler

Put a B T Coupler between power tube and speaker and you will improve your reception wonderfully.

You will not only secure better tone but also get much greater volume, particularly on air column speakers.

You will protect your speaker also and prolong its life

Note from illustration that various combinations enable you to use the one giving best matching between speaker and tube

Fits inside cabinet or on table. No tools necessary. Price $7 50.

The A. C. Power-Six

The new "A" Transformer replaces storage batteries and enables you to run your Power-Six direct from the electric socket

There is nothing later—or better.

Tell us just what your problem is when writing.

Price of "A" Transformer $7.50.

Price of Complete Diagram and Instructions for changing or building new A. C. Power Six. $1 00.

"Better Tuning" is an 80 page booklet answering the latest questions in radio.

It tells about B-T sets. If you are also interested in parts please state same when writing.

Use Coupon.

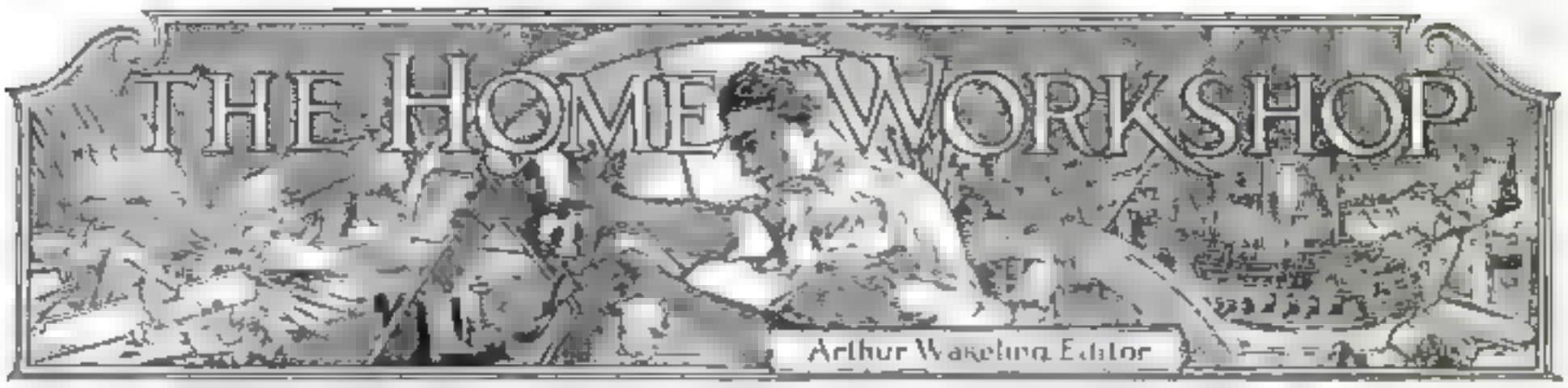
520 S. CANAL **BREMER-TULLY MFG. CO.** CHICAGO ILL.

PIONEERS OF BETTER TUNING

Send 80-page "Better Tuning," 12th Edition to

I am interested in factory-built
A.C. sets Speakers
B-Units Kit Sets.
I am a dealer Consumer Set Builder

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.



At Last—The True "Santa Maria"

How to Build a Simple but Reliable Model of the World's Most Famous Ship As She Really Looked

By E. ARMITAGE McCANN

MOST model makers would like to build a model of that famous ship, the *Santa Maria*, if they knew that the result of their efforts would be reasonably like the vessel in which Christopher Columbus sailed to America. With the aid of the accompanying plans, any handy man now, for the first time, can do this.

It can be safely asserted that none of the models of the *Santa Maria* seen here, there and everywhere are much like any vessel Columbus could have used. The best of them are a century out of date.

The "stock models" are obviously not like any ship that ever floated. They are not ship models at all and, although one has no objection to them as decorations, to advertise them as authentic reproductions is false and misleading.

The carefully fashioned models built to the plans of the fabulous replica of the *Santa Maria*, and sent to this country for the World's Columbian Exposition at Chicago in 1893, are another matter. They may be considered as good models of a seventeenth century carrack.

It is perhaps needless to question a convention that has existed for thirty-five years and to say that all the models that have been made from that vessel, including those in national museums such as the Smithsonian and South Kensington are wrong; but in this the writer has the support of all the real experts who have studied the subject. They are agreed that she is much too fancy a vessel of the seventeenth century, instead of an old carack of the fifteenth.

Henry B. Culver, in his "Book of Old Ships," illustrated by Gordon Grant, says:

"It is unfortunate that the well-meaning Spanish gentleman who prepared the plans and designs for the Columbus fleet sent to the United States for the Chicago celebration of 1893 could not have had the benefit of the efforts of these English scientists. It is safe to say that if he had, the alleged replica of the *Santa Maria*, the principal result of his earnest, if misdirected efforts, would not have borne the form she does for she is still in existence, disseminating to this day

Continued on page 8

This beautiful and decorative model of Columbus' vessel is authentic in all of its essential details

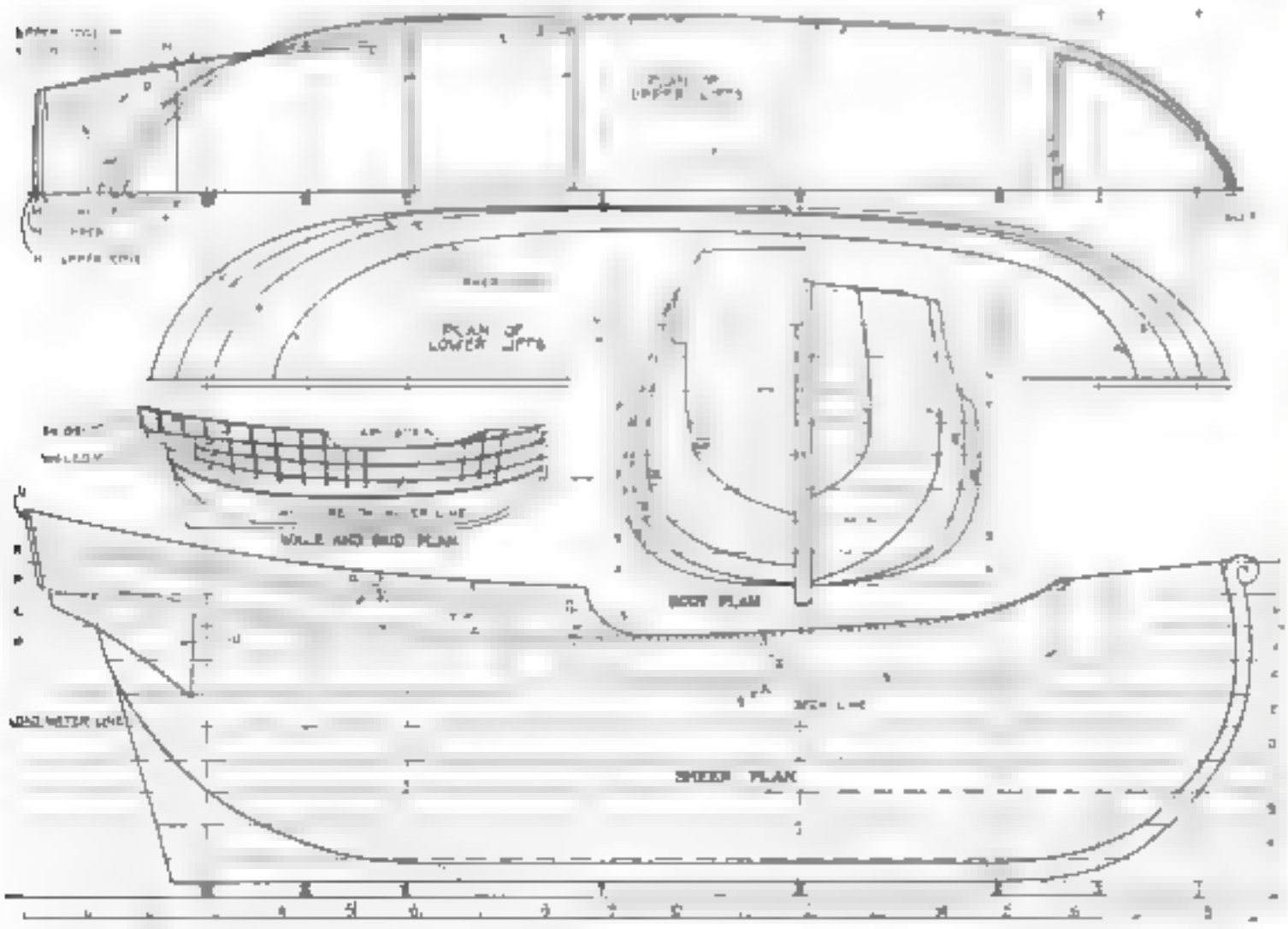


Fig. 1. Hull measurements, sheer and lift plans, and other important dimensions are clearly indicated

New Ways *to Decorate* Gifts

Transforming Inexpensive Novelties into Artistic Christmas Presents — Polychroming, "Pour Finishing," Other Methods

By BERTON ELLIOT

ARTISTIC and genuinely desirable Christmas gifts can be prepared at absurdly little expense if you know the secret. It is just this: Buy well designed but cheaply finished novelties and art wares, or else get entirely unfinished articles, and decorate them yourself by the easy methods which have been recently devised for amateurs.

All manner of things may be decorated. Vases, candlesticks, flower holders, bowls, book ends, plaques, boxes, door stops, salt and pepper sets, cake boards, wooden spoon and fork sets and the like may be found in ten-cent stores, variety shops and hardware and house furnishing stores. Woodenware, glass, pottery, china and metal articles may be purchased unfinished in artists' supply and department stores. And in every home there are already many objects waiting to be redecorated.

Following are a few methods which will enable you to undertake an almost unlimited range of work:

Polychroming is the application of a plastic composition, which is stippled into textured or relief effects and then colored, bronzed, and wiped off to produce a multi-colored surface.

Various plastic materials are employed. Gesso clay or Italian clay, sold in small cans, is extensively used, as a plastic wall paint. A gesso preparation may be made by mixing together about ½ pt. whiting, ¼ pt. liquid glue, and 3 teaspoons each of varnish and linseed oil. The proportions may be varied slightly as necessary to produce a composition of good working consistency it must be sufficiently stiff to stay put when modeled into relief effects.

THE material is brushed on to the surface or applied with a knife. After it has set for a few minutes, it is stippled in various ways. A brush, spoon, spatula or paring knife may be used to produce scrolls and fanciful designs. Confectioners' icing tools or pastry ornamenting tubes are sometimes used for more elaborate designs.

When thoroughly dry, the surface is usually given a sealing coat of shellac or special size adapted for that purpose. With some plastic compositions this is not absolutely necessary, but it is always a safe practice. It may then be given any color treatment desired.

How a preserve jar or any inexpensive piece of pottery may be decorated by pouring lacquer over it

WALL p[illegible] made from a [illegible] oard pan[illegible] covered with [illegible] burlap cloth and shells laid on that it resembles an old painting. The frame is painted to [illegible] gesso. The [illegible] finished picture was varnished with a stain to [illegible] design, and [illegible] over a [illegible] background for [illegible] and [illegible] any desired [illegible]

A TYPICAL method is to give the surface a foundation coating of gold, silver, copper or green bronze, or a suitable tint of flat wall paint, enamel or lacquer, and then to use for the polychroming either oil colors, flat wall paint, glazing colors or the new brushing lacquers. The glazing colors are applied with a brush. Before they have commenced to set, they are wiped with a cloth from the high spots and other places, as may be desired. One or more colors may be applied and wiped off, followed when thoroughly dry with other colors handled in the same manner. One color peeps from beneath the edge of another producing beautiful effects. Frequently the polychroming is done entirely with bronze powders—first a foundation brush coat of gold, silver or any desired shade, then a coating of Japan gold size, and a final "patting" on of bronze powders of other colors with a piece of velvet.

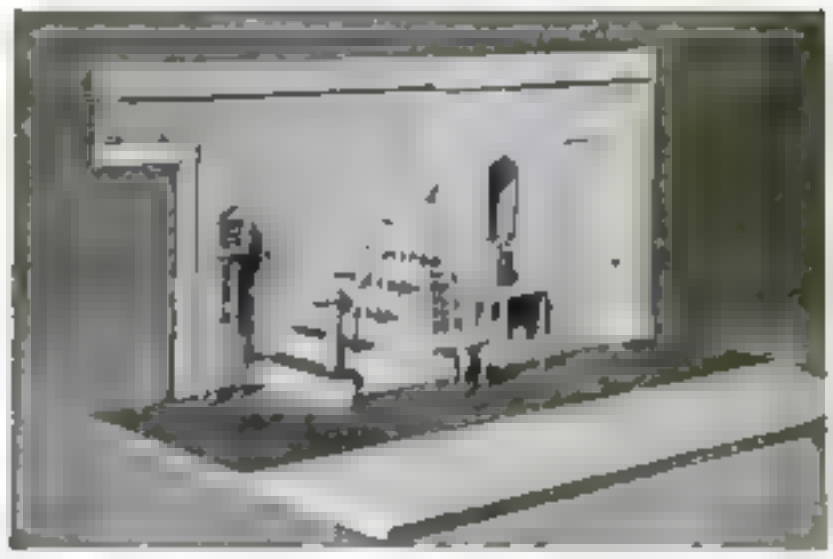
"Pour finishing" is one of the newest forms of treatment. Brushing lacquer seems to be especially adapted for this work, both as to working properties and appearance. The only supplies necessary are several cans of lacquer of different colors and a drip pan, which may be any pan, plate or other shallow receptacle.

The object to be decorated is placed in the drip pan and one color of lacquer poured over it so that it runs down the sides. If the object is set up on a block a little smaller than its base, the color will drop off and not form a bead around the bottom edge. Before the color has commenced to dry, another color is poured on, or as many colors as may be desired, until the surface is entirely covered. The lacquer runs down in irregular streaks and stripes, blending in fanciful formations and producing the most exquisite effects.

A LITTLE variation of the treatment will cause a different appearance. For instance, if each color is allowed to dry until it becomes "tacky" before the succeeding color is poured, there will be less blending and a more definitely streaked effect. Still different blends may be produced by those with free-hand or china-painting experience by pouring on one or two colors and working up scrolls and other designs. Vases, cruets and bottles of artistic shapes also are sometimes decorated by pouring the lacquer into the (Continued on page 120)

A Christmas Doll's House

It Can Be Made at Small Cost by Any Handy Man or Boy—Complete with Furniture



How the stairs are built and the hall is furnished with a miniature clock, table, chair and mirror

By F. CLARKE HUGHES

NO CHRISTMAS gift is apt to delight a small girl quite so much as a really fine doll's house. To her it is a fairy home where her doll children can live and play. She can devise new furnishings, redecorate the rooms, and sweep, dust, wash and cook to her heart's content.

And after all, isn't that the secret of a satisfying toy? It must allow the child to do something genuinely constructive and stimulate her imagination and ingenuity. At the same time it should possess a sense of grown-up reality. A doll's house does all this, especially if it is complete and realistic, a model of a house as the one illustrated on this page.

AT FIRST glance this doll house, based upon one of the most popular colonial designs may appear to be complicated in its construction, but when examined closely and studied well it will be found relatively simple for any handy man or boy to build in spare moments in his home workshop. Only household tools are needed and no high degree of skill or previous experience is called for.

To make the work still easier, two supplementary blueprints, each 15 by 22 in., have been prepared. These contain working drawings of both the house and its principal furnishings, many of the details being full size. All the drawings are much larger and more complete than it is possible to give in the limited space available in the magazine. The blueprints can be obtained by sending 30 cents to the Blueprint Service Department of POPULAR SCIENCE MONTHLY (see the list on page 102)

The first thing to do is to study the drawings until a clear understanding of the method of construction is obtained, the next is perhaps to examine the list of

The house is a realistic scale model of a fine Colonial house

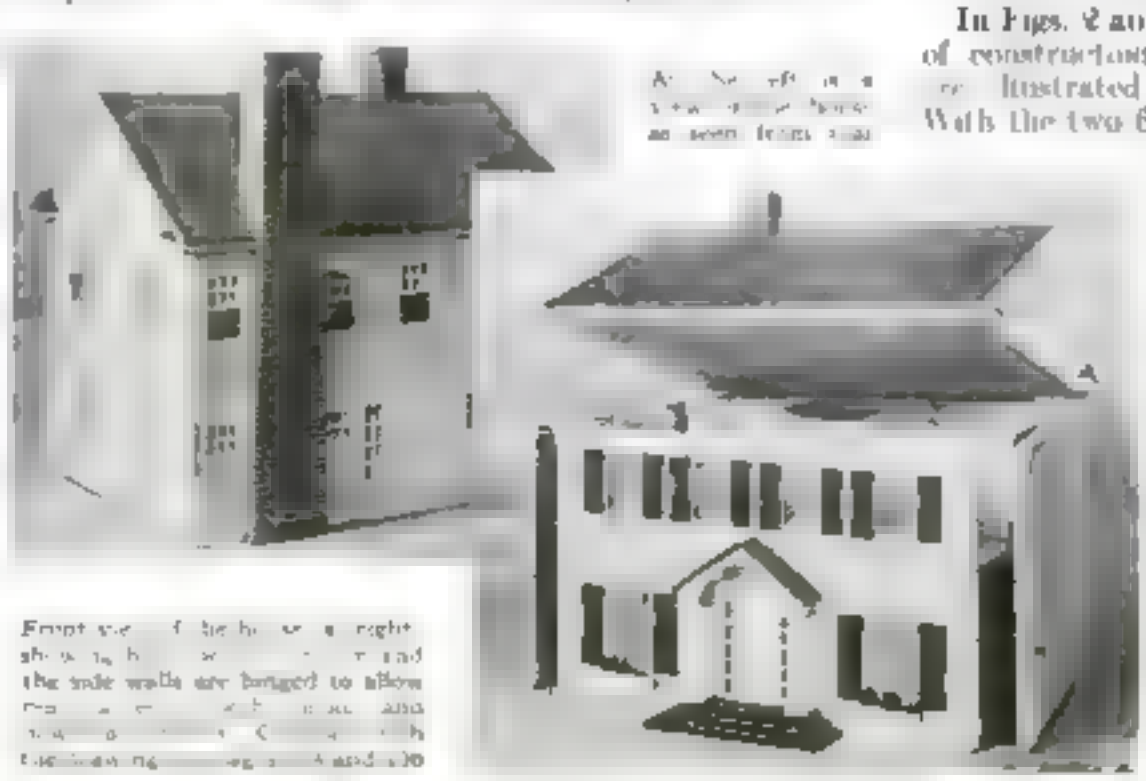
numbers and sizes of all the parts needed for the house as given on Blueprint No. 72, or, if the blueprints are not used, to compile such a list. It may be made from the drawings which are reproduced on pages 104, 106, 108 and 110.

The best material to use is either plywood or wallboard, because they do not readily warp or split. The thickness for all the major parts of the house should be preferably ½ in., although ⅜-in. stock can be used if the other cannot be obtained. Of course, any difference of thickness will make a slight variation in the length of some of the parts. As many of these materials come in regular sizes of 4 ft., they may be glued together and used double thickness to make up.

VENEERED stock such as is found in some packing boxes may be made use of in the construction of the house. This usually is ⅛ in. thick and may be had very cheaply.

The drawings accompanying this article and those on Blueprint No. 72 are for a house that is just one twelfth the size of a real house, and all of the furniture and parts are planned on this scale. A smaller house may be made by reducing the dimensions proportionately. To make this easy, a scale has been placed on Blueprint No. 72 for your convenience if you wish to build a house 21 by 25½ in. instead of 28 by 34, base measurements.

In Figs. 2 and 3 are shown the method of construction; the dimensioned parts are illustrated fully on Blueprint 72. With the two floor boards, Nos. 3 and 4, squared and sandpapered and the upper ceiling board No. 2 in shape, the position of the walls should be marked off carefully, using the plans in Fig. 1 as guide. Nos. 3 and 4 are each ½ by 27 by 33 in., while No. 2 is ½ by 20½ by 34 in. The main floor board is reinforced on the edges with a 1 by 2 in. strip marked 4A in Fig. 3; this extends all the way around the edge and across the middle.



As the second floor

(Continued on page 104)

New Ways to *Light* Your *Tree*

How to Create Brilliant Christmas Effects—An Illuminated Stand, Varicolored Spotlight and Other Novelties

By LAWRENCE B. ROBBINS

DECORATING the Christmas tree is truly an art. With so many varieties of electric bulbs available in countless sizes, shapes and hots, you can create the most gorgeous effects, and play with light and color like a stage decorator. Only a little ingenuity is required. And even if you happen to live in an old house not regularly lighted by electricity, you can illuminate the Christmas tree with six-volt bulbs operated by one or two storage batteries hired for the purpose or even taken from an automobile.

Find some novel scheme of decoration. That's the secret of setting up a noteworthy tree in these days when all Christmas trees are so excellently ornamented!

For instance, look at Fig. 1. It is a tree stand with water to keep the tree green, combined with a unique, effective yet inexpensive illuminating scheme.

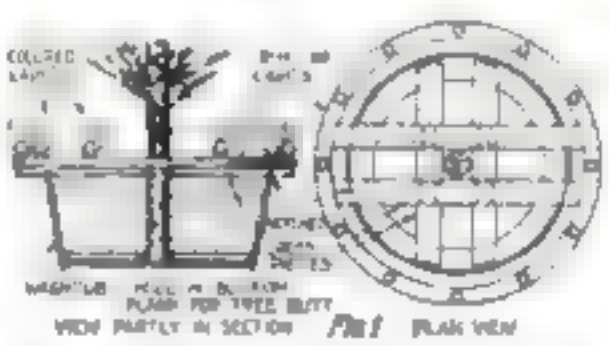
The base is a common washtub. Use a fairly large one and make it water-tight. In the bottom fit a plank with a hole in the center to take the butt of the tree. Provide two narrow boards to go across the top edge of the tub on each side of the tree trunk. Cut notches in the underside of the boards to fit over the tub rim, then bolt two similar pieces to the underside of the first, at right angles to them, so as to leave a square opening in the center for the tree. The lower pieces should fit tightly inside the tub rim.

Get a stout wagon wheel rim, if possible, or build up a two-ply rim by sawing out segments of wood and nailing them together in such a way that the joints between two segments in the upper layer will come in the middle of a segment in the under layer. Place the rim over the extending ends of the two upper cross planks and bolt it in place. Then fasten electric light sockets around the rim about 6 in. apart as shown. Use different colored bulbs and introduce a flasher in the circuit, if one is to be had.

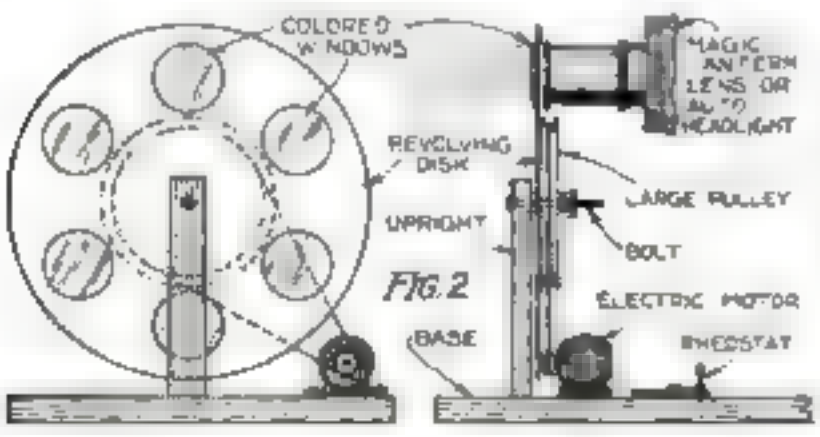
Partly fill the tub with water, insert the tree and cover the tub with Christmas paper or suitable decorations. When the tree is decorated, the upstreaming, varicolored lights and the reflection in the water below will give an unusually colorful and charming effect.

If the inside of the tub is unsightly or it is desired to hide the water from view for any reason, a disk of cardboard may be fitted around the tree trunk and laid over the tub. Then the entire support can be decorated with suitable crepe paper to hold the tub and framework.

Magically beautiful effects are possible with simple homemade apparatus. Success depends upon the novelty of your scheme of decoration



The tub base firmly supports the tree and the water helps to keep it green for a long time



A home modification of the flashing colored light disk used on the stage provides unique and beautiful effects

Another effective novelty is to string the tree in the ordinary manner with varicolored bulbs intermingled with long streamers of tinsel. Place a small electric fan, pointing slightly down, at each side of the tree near the top. The conflicting breezes from the fans play among the tinsel streamers and keep them fluttering. This gives a surprising sense of animation to the tree, especially when a flasher is also used.

A charming color disk that will automatically play lights of various color upon the decorations of the tree is another means of making a striking display. Such a color disk can be made by any man handy with tools at small expense.

Cut out a disk of wallboard about 24 in. in diameter. Choose stock that is perfectly flat, and if there is any likelihood of its warping, nail the edge to a light wooden hoop of the same diameter. Next saw out a wooden pulley of 4-in. stock and groove the edge. Drill out the exact center, place the wallboard disk over the pulley with the two centers coinciding and fasten them together with small nails. Then cut six round holes about 6 in. in diameter in the remaining face of the disk, spaced equidistantly. Cover each hole with a piece of celluloid, yellow, blue, red, and so on. Such celluloid often can be obtained from a large stationery house, but it can be prepared at home by coloring clear celluloid with aniline dyes.

Old ornaments can be fitted with bulbs to give mellow lighting

Now make a wooden base of considerable size, fasten an upright wood support near one end, and provide a ½-in. bolt at the top as shown in Fig. 2. This acts as a spindle on which disk and pulley turn. Place a thick washer on each side and insert a cotter pin through the bolt as a retainer. The disk and pulley should revolve easily without wabbling. Just below the pulley and at one side of the base, mount a small electric motor with a small pulley and belt it to the disk pulley with a round

(Continued on page 134)

The Gift--that will never wear out

—the grindstone-tested

Ingersoll

No longer need you "give until it hurts." Or worry about making an acceptable selection

Thanks to Chas. H. Ingersoll, for many years manufacturer of famous popular priced watches, you can choose the most desired of gifts high grade tested fountain pens—without embarrasament to your Christmas budget.

Now, you can remember several very handsomely for less than you paid heretofore for a single pen of comparable size, color, beauty and wearability

The outstanding distinction of all Ingersoll pens is the hard Iridium tip on solid 14 Karat gold nib proved by the official grindstone test (described in last column of this page) to be good for unending wear and smooth writing.

Other Ingersoll features unsurpassed in even the highest priced pens include the simplest and most reliable of self fillers extra large ink capacity clips that hold but don t wear the pocket and a lifetime guarantee.

All models are similar in construction and quality, differing only in sizes and styles of holder and sizes of gold points And every Ingersoll is everlasting tipped with hard Iridium

Ask your dealer to show you the newest Ingersoll oversize and junior models at $1 50 and $2 00 with unbreakable Durrac barrels in brilliant red, green, black, and mottled color effects. Packed in attractive gift boxes.

Standard Nickel-Silver Barrel Ingersoll Pens-Men's, Ladies' or Junior Model $1.00

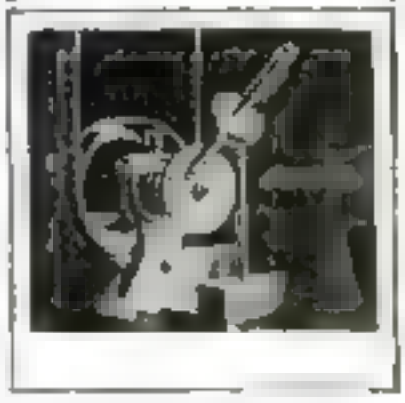
Oversize Ingersoll Beauties, Red, Black or Green Durrac Barrels (model shown) . . . $2.00

Ladies' and Junior size Ingersoll Beauties, Red or Black Durrac Barrels $1.50

Sold by dealers everywhere

If your dealer is not yet stocked with the complete Ingersoll Line, send us correct price for model desired (men's, women's, juniors') specifying color, and we will fill your order direct

CHAS. H. INGERSOLL DOLLAR PEN CO.
563 North Arlington Ave., East Orange, N. J.



Officially Tested By PROF. LOUIS H. YOUNG of the staff of the MASS. INST. of TECHNOLOGY for the "Y. C. LAB."

Everybody knows that all the wear of a pen comes on its point.

Prof Young recently proved the everlasting wearing quality of the hard Iridium tipped points of Ingersoll fountain pens by grinding 10 of them for one a full hour each on a whirling grindstone.

Not one Ingersoll point was injured by this drastic test—equivalent to 15 miles of wear over a surface gritty enough to grind the hardest metals.

Ten common steel pen points far more durable than the average fountain pen with soft gold point subjected to the same test, were each rendered absolutely useless in a few seconds!

Scientific calculations show that it would take 21 years of writing at the rate of 30 words a minute day in and day out for TEN HOURS A DAY to inflict the same amount of wear as this single hour on the grindstone

Ingersoll

$1- $1.50 and $2.00 PENS

Making the Most of the Vee

Easily Made Fixtures Help You to Locate Round Work for Drilling, Milling and Boring

By HENRY SIMON

ONE of the stepchildren of the shop is the vee-block. But so long as things are turned from metal, vees will be used for some of the operations on them. Almost every shop owns one or two sets of such blocks of conventional design, with the usual clamps, and very good tools they are. As a rule, however, the possibilities of the vee as an aid to the machinist and toolmaker are not fully appreciated.

The vee has one outstanding advantage. It automatically and accurately centers round work irrespective of variations in diameter. That this is an extremely valuable feature is realized when we consider that any other means of accomplishing the same result requires mechanism of one sort or another, unless there is a semi-cylindrical bed or bearing of the exact radius of the part to be held—something which it is possible to provide only in a few cases.

The trouble with vee-blocks of ordinary design, however, is that they do not go far enough in providing for the reception, location and holding of work of a variegated nature. To try to mount a set of such blocks on the faceplate of a lathe, for instance, is to go in for a troublesome and unsatisfactory makeshift. Again, if the centering capacity of the vee is to be turned to real account, it is necessary to provide for the easy centering of the vee itself, and unless such devices are carefully thought out, they are apt to prove of questionable usefulness.

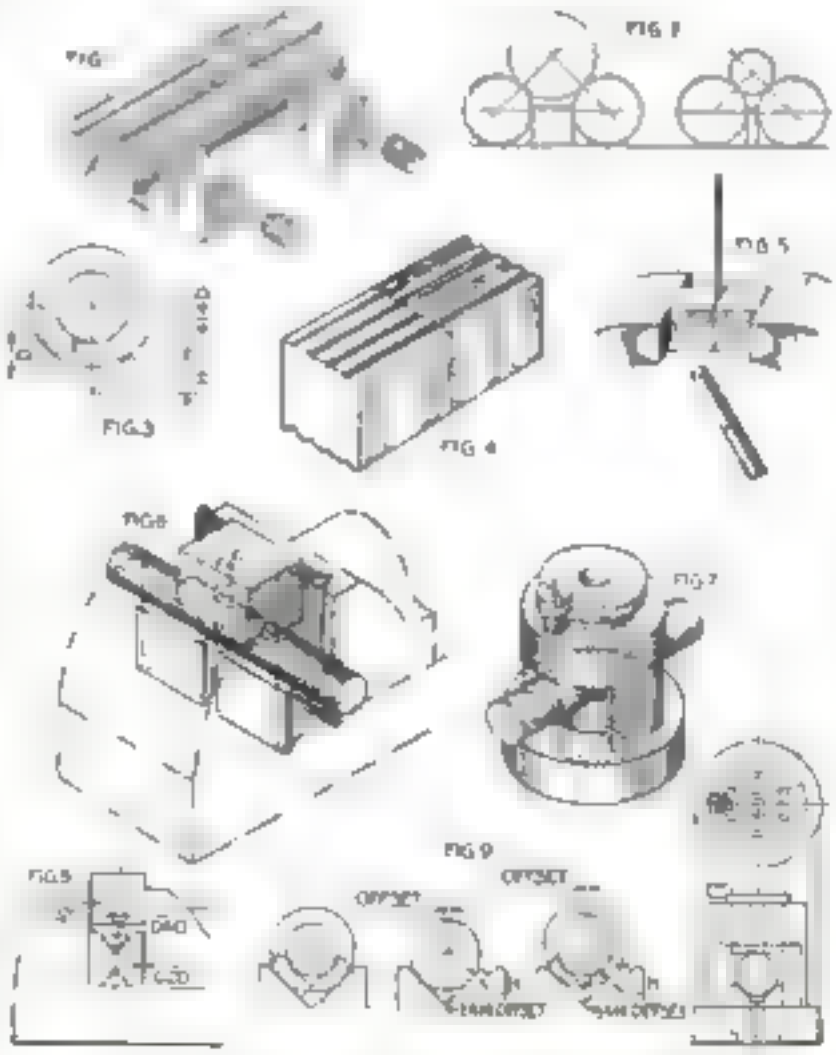
It is the purpose of this article to show some good ways of using the vee, as well as to present some simple appliances, by the use of which many an otherwise difficult job will be made easy.

Starting with the simplest, let us consider how to improve a vee, or its equivalent when none is at hand. All we require is a pair of machinist's clamps, such as are found in any shop, two lengths of cold rolled steel or drill rod, and a couple of small blocks of rectangular cross section and slightly wider than half the diameter of the rods used. By clamping these together as in Fig. 1, we have a most effective vee equivalent of practically any length we may desire, and with a passage for the drill all made. Figure 2 shows that the contact is exactly identical with that given by a regular vee, and also illustrates the approximate proportions of the three members in relation to the work. Cases may arise when vees of exceptional length are required, and this simple method furnishes a ready way of providing them. If necessary, one or two additional clamps and blocks may be used. A permanent device may also be made merely by soldering the blocks in place on the rods, so that they can be used without clamps.

Two pieces of bar stock and a pair of metal blocks will serve as a useful vee substitute

A way in which a standard commercial pair of blocks may be used for center drilling to close limits is shown in Fig. 6. The only special accessory that is required is exceedingly simple. It consists of a block of steel of the same thickness as the vee-blocks with a hole of the required size drilled through the center of it. A second hole of about the same size is drilled laterally in line near one side. A pin with a head a trifle larger than the second hole is pushed into the "jig" block from below. The head of the pin enters the space between the two vees when the block is on top of the work. A piece of fine emery cloth is placed against the movable jaw. With the jaw lightly tightened, the work can be slid along until it is in the desired position.

The jig block is then given a smart tap, *(Continued on page 117)*



Center or offset drilling are easy by the method shown in Fig. 6. A simple round stock drill is illustrated in Fig. 7

MANY timesaving shop ideas are contained in the continuation of the Better Shop Methods Department, to be found on pages 114 to 120.

Metal Work for Beginners

Setting Up a Foot-Power Polishing Machine Blowtorches and Heating Equipment for Soldering

By EDWARD THATCHER

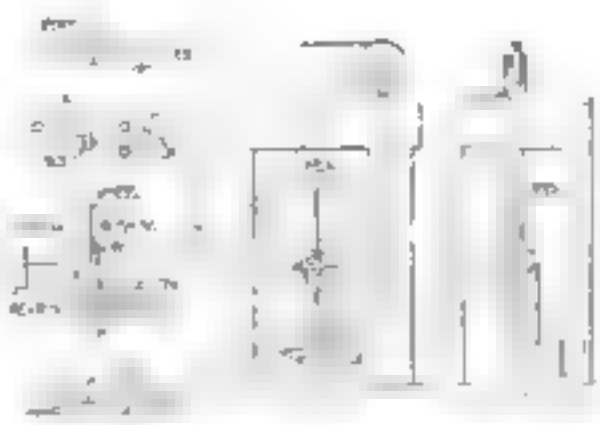
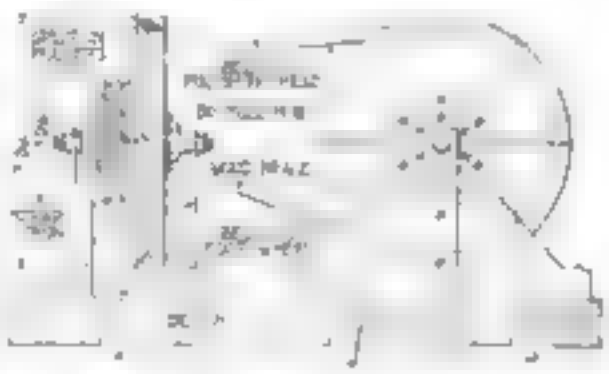


Fig. 1. High spindle speed suitable for polishing can be obtained by the use of a ball bearing countershaft to cut down friction

IN EQUIPPING a home workshop for decorative metal work and model making, you will find many uses for a small polishing head or lathe driven by either a foot wheel or an electric motor, together with several small polishing and buffing wheels and an emery wheel or two.

Hand buffing or polishing sticks also are valuable These are made by gluing leather to strips of wood and charging the surface with various polishing compounds. They are used like files.



Figs. 2 and 3. A bicycle wheel hub is excellent for the countershaft The spool pulleys are held in place by screws in spoke holes

Drilling, grinding and polishing may be quickly done with a small polishing head if the work is small as these inexpensive tools are fitted with a drill chuck a taper polishing spindle for buffing wheels, and nut and collars for a small emery wheel Do not make the mistake, however of thinking that you can polish large bowls or other bulky pieces on a small foot driven machine or that you can use large grinding or polishing wheels on a small head. Polishing takes power, and large work is best polished by hand or on a power driven head.

A small polishing head may be mounted on the base of an old sewing machine and belted to the foot wheel, or it may be fastened on one end of the bench, with the belt passing through the holes in the bench to a foot wheel on the floor. Such foot wheels may be purchased, but it is often possible to pick up a suitable wheel at the junk yard and rig up a treadle for it. The wheel should be quite heavy and well mounted and balanced.

While a fairly high speed may be obtained from a polishing head mounted on a sewing machine base, far better work can be done if a countershaft is placed between the foot wheel and the polishing head, as shown in Fig. 1.

The writer has such a rig in his shop for small work. The ball bearing countershaft was made of an old bicycle wheel hub on which were mounted two wooden pulleys. The spoke holes in the flanges on each side of the hub were used for the screws which hold the split pulleys to the hub. Figs. 2 and 3.

The foot wheel is 18 in., the small

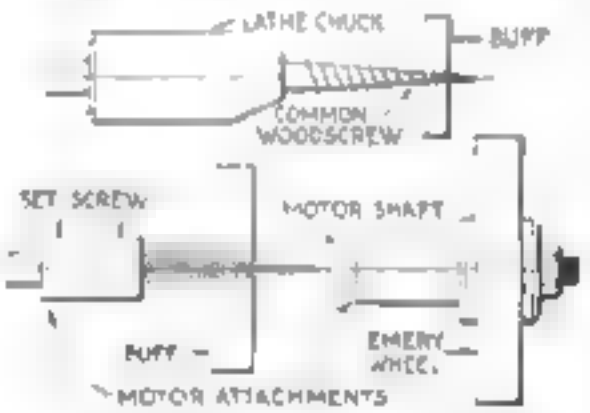


Fig. 4. Attachments to fit the shaft of the ordinary electric motor permit you to turn it into a grinding, buffing or polishing head

wheel on the countershaft 9 in. and the large wheel on the countershaft, which runs to the pulley of the spindle, is 7 in. in diameter The pulley on the spindle is 1¼ in. in diameter a common size.

I have made many foot power machines and used a number of commercial ones, but for speed and easy running this little

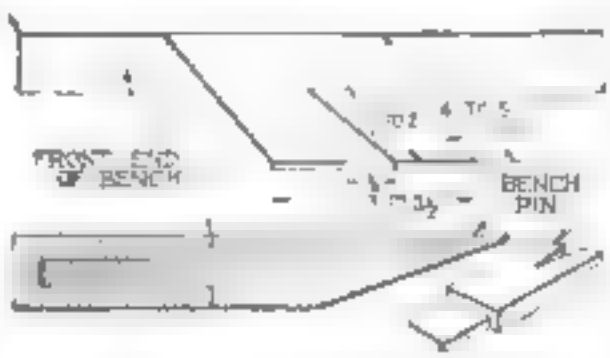


Fig. 5. A bench pin mortised into the front end of the bench is useful for many types of jobs. It should be made from sound hardwood

one with the ball-bearing countershaft beats them all.

If you make up such a rig as this, you will find that the construction of the foot treadle is important Two suggestions are illustrated. The location of the connecting rod on

(Continued on page 132)

PICK YOUR PEN POINT BY COLOR

We have solved the problem of pen point selection. The color of the band on the holder tells the whole story. You can now select with confidence exactly the pen point best writing requires.

A fine, broad, stub, flexible or stiff point may be selected at a glance. You can't go wrong.

The merchant who sells Waterman's will be glad to demonstrate. He and we want you to be perfectly pleased.

Ask to See

Waterman's Number Seven

Try all six pen points. Select the one that suits you best.

When you buy a Waterman's you buy perpetual pen service.

It will pay you to spend a few minutes in selecting exactly the pen you should have.

Guaranteed since 1883 and until 1983
—one hundred years of pen service

L. E. Waterman Company
191 Broadway, New York
Chicago San Francisco Boston Montreal

STANDARD—Suits most writers. A splendid correspondence point. Medium flexibility. For home and general use.

RIGID—Tempered to proper point hardness. Will not shade even under heavy pressure. Unequaled for manifolding. The salesman's friend.

STIFF, FINE—Wears without pressure. Makes a thin, clear line and small figures with alarming accuracy. Popular with accountants.

FLEXIBLE, FINE—As resilient as a watchspring. Fine, tapered point ground fine to shade at any angle. Loved by stenographers.

BLUNT—An engraver's stub point. Makes a broad line. May be held in any position. Liked by rapid writers.

ROUNDED—A different pen point. The tip is half ships. Makes a heavy, characteristic line without pressure.

$7.00

Number Seven

Made of beautiful resilient Ripple stainless rubber, protected with a lip-guard to prevent breaking, and an unequaled, patented Ring device.

Waterman's

The Man Group

A Million Man Market
A Four Billion Dollar Buying Power

YOU are one of an army of *a million men* who buy the above magazines known as THE MAN GROUP. Several other million men read these magazines. 187,000 of the subscribers earn from $10,000 up to $40,000, $50,000, $100,000 or more per year. In your midst are the great industrial and financial leaders of America. Many of you are the successful younger executives, from whose ranks will be chosen the business leaders of tomorrow.

You are representative of the solid, substantial, staple earning and spending power of America. Some of you are young men—just starting business careers that will, in a very short time, raise your incomes to $5,000 or $10,000 a year or more.

Estimating the incomes of 1,000,000 subscribers of these magazines, at the very minimum, according to statistics furnished by Dr. Daniel Starch of the Harvard School of Business Administration for the American Association of Advertising Agents, they are away over *Four Billion Dollars*. The actual earnings of the readers of these magazines are probably two or three times that sum.

Our purpose is to interest you in this enormous Man Market. For instance, you men buy your own hats—millions of hats; you buy your own shirts and collars, underwear, hosiery, garters, shoes, clothing; you buy your own razors and shaving cream and cigarettes and cigars. You, at least, have something to say about the automobile that goes into the family garage. You buy all the trucks. You buy tires and oil and gas.

Do you, or do you not, have something to say about the kind of roof that goes on your home, bath room fixtures and the furnace?

Without your executive ability, sales skill and earning power, the market in America for all products, whether used by men, women or children, would be reckoned in millions instead of billions; and don't forget that a billion is one thousand million.

The readers of the Man Group magazines *manufacture* nearly all of the merchandise that is made in this country. They *advertise* and *distribute* and *sell* this merchandise.

They also *buy* a whale of a lot of it.

Will you please write me a frank personal letter telling me what you or your company *make;* and especially what you personally *buy* for the family, for yourself and for your company?

Ruggles & Brainard *Inc.*

Color Pages

The Graybar Building
New York City

How I Built a Desk *from* Scraps

The Secret Lies in the Method of Painting and Glazing, Which May Be Used for Any Homemade Furniture

By F. N. VANDERWALKER

WHAT can be done in the line of furniture building by one with no special training in the work is shown in the accompanying illustrations of a desk. It was made at odd times from pieces of lumber left over from the building of a new home—yellow pine, birch and oak. Some scraps of moldings were pressed into service, and the paneled back was made from a section picked up from an old building being wrecked.

Figures 1 and 2 show the completed desk with handmade hardware cut out at home from strap iron, heated in a coal burning water tank-heater stove, and pounded into the shapes wanted. The making and finishing of the hardware is another story and will be presented later.

The inside of the desk is unusual in that the pigeonholes open from the side and not from the front. They are located behind the two side panels and consist of shelves, one above the other. By this arrangement we have none of the unsightly disorder which is apt to result when the openings are in front. In Fig. 1 is shown, too, the desk board, which slants a little to be comfortable when writing. It must be pushed back, of course, before the doors can be closed.

THE construction was done with the carpenter's tools which every handy man has. All pieces were nailed, screwed and glued firmly together, because if there is anything a homemade thing must do, it must hang together for all time. The family is apt to overlook a failure in factory made furniture that only sparks but stands up with furniture that has the look of broken

A piece to take up [illegible] of lumber and odds and ends which in places were none too smooth, could hardly be finished in stain or natural color with good results. The defects had to be covered over and smoothed up. Consequently, the choice of finish was limited to paint or enamel. Some of the most beautiful and expensive furniture is finished in paint, and glazed and varnished or lacquered. That finish was decided upon.

The first step was to sandpaper the wood with No. 1 paper to make it as smooth as possible. Next, the surface was dusted and wiped clean with a damp cloth.

In this case the first coat was white lead mixed with boiled linseed oil and turpentine, half and half. A little lampblack, ground in oil, was added to make a slate gray. This paint was brushed out well to force it into intimate contact with the wood. Two days were allowed for drying and then the coat was lightly sandpapered with No. ½ paper, just enough to cut off any dust and dirt nibs.

A number of seams, joints and nail and screw holes had to be filled. This was done after the first coat of paint because putty does not stick well to new wood, the wood absorbs the oil binder out of the putty.

PUTTY for this purpose was mixed from white lead-in-oil, a little dry whiting and a few drops of floor varnish. The procedure is to spread some dry whiting on a board or pan, take a lump of the white lead paste and with a putty knife mix it into the dry whiting. When it is about like bread dough, take it up in your hands and knead it to a soft but firm consistency. Force it into all holes and cracks and smooth off with the putty knife. Let the putty dry at least overnight and sandpaper the places.

To build a smooth [illegible] level surface, the next operation is to apply [illegible] of [illegible] paint [illegible] muddle-coat filler. It is a stiff colored paste which can be had from any paint store handling automobile painters' materials. Thin it to about the consistency of cream with turpentine only. Apply one coat with a 2½-in. brush, let it dry overnight and sandpaper it hard with No. ½ paper. No matter if you do cut

(Continued on page 130)

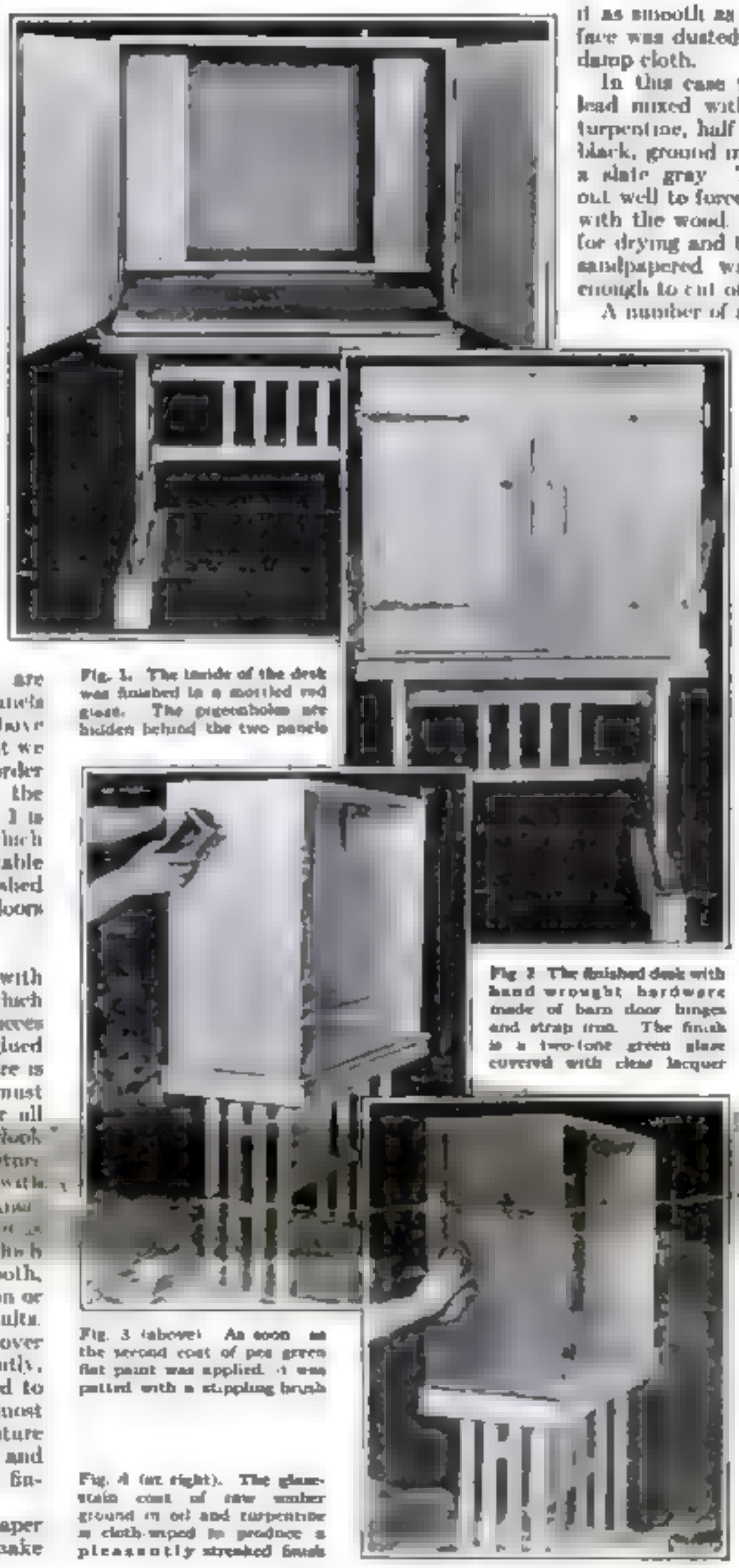


Fig. 1. The inside of the desk was finished in a mottled red glaze. The pigeonholes are hidden behind the two panels

Fig. 2 The finished desk with hand wrought hardware made of barn door hinges and strap iron. The finish is a two-tone green glaze covered with clear lacquer

Fig. 3 (above) As soon as the second coat of pea green flat paint was applied, it was patted with a stippling brush

Fig. 4 (at right). The glaze-stain coat of raw umber ground in oil and turpentine is cloth-wiped to produce a pleasantly streaked finish

The True *Santa Maria*

(Continued from page 7)

Captain McCann working on the aft deck structure. It is at this point that authorities appear to agree that other *Santa Maria* models err. They should not have an inclosed after castle

a deplorable amount of misinformation, while models fashioned upon the same erroneous data are legion.

H. C. Anderson, the English expert, says of the model presented to the South Kensington Museum: "One should not look a gift horse in the mouth, but one may look a gift model to the rigging." He questions a bolstay in a ship of some 300 years before the generally accepted date of its introduction, the mainstay's splitting in two parts and setting up two eyebolts on the forecastle, and the shape and trim of the mizzen.

Other important features which are gravely questioned are the square tuck (lower part of the stern), inclosed after castle, the entire sail plan, rigging and most of the decoration.

One learns that Christopher Columbus encountered fanatical opposition to his mad adventure and that, despite royal mandate, [illegible] would supply [illegible] service, [illegible] the "Santa [illegible] large and heavy but very solid. Although improper for the service now assigned to her, neither Columbus nor his counsellor, Father Juan Perez, dared to refuse her for fear of thus protracting the delay already too greatly extended.

Columbus could not even get this vessel properly caulked. How then would he contrive to make of her the gaily decorated smart craft usually depicted?

Nevertheless, it was the habit to paint colorfully all manner of vessels, but red emblems were considered almost essential and Columbus was a High Admiral of the Ocean Sea, therefore he would be entitled to flags and banners, which would be supplied by his royal backers, and the shields of his

[illegible] on page 120)

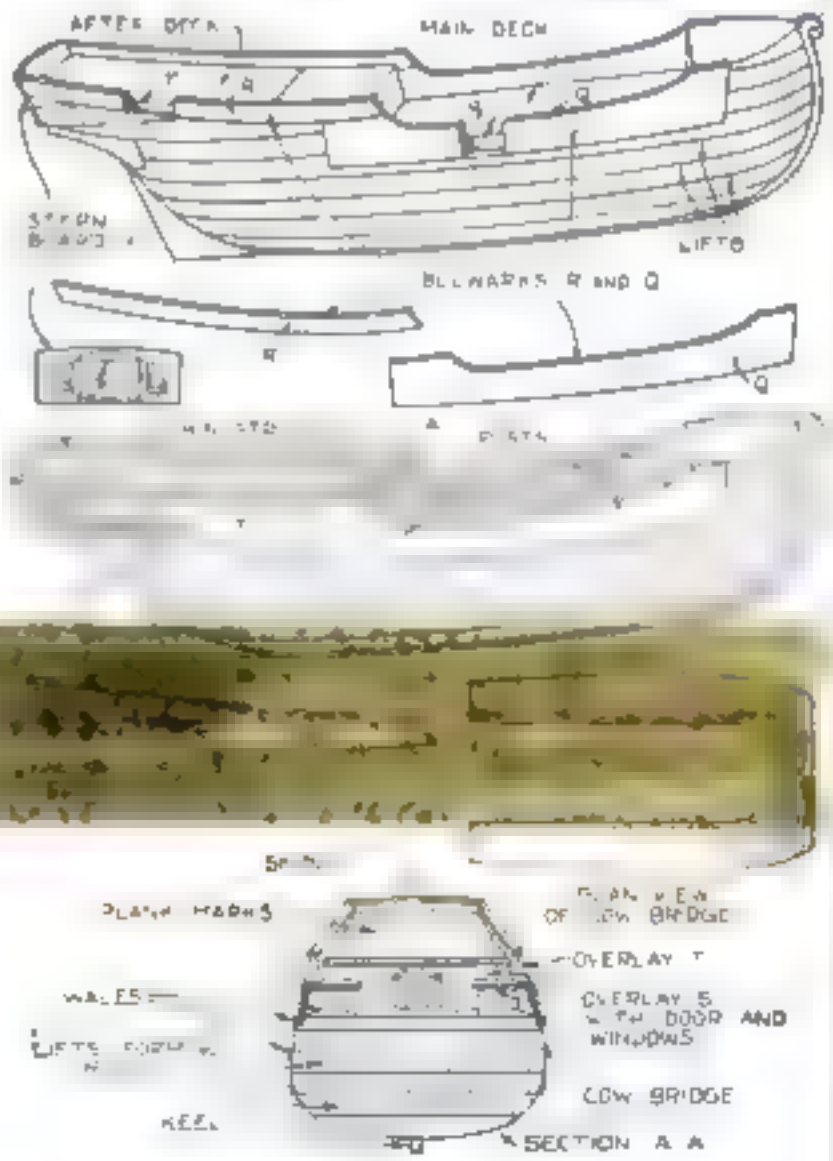
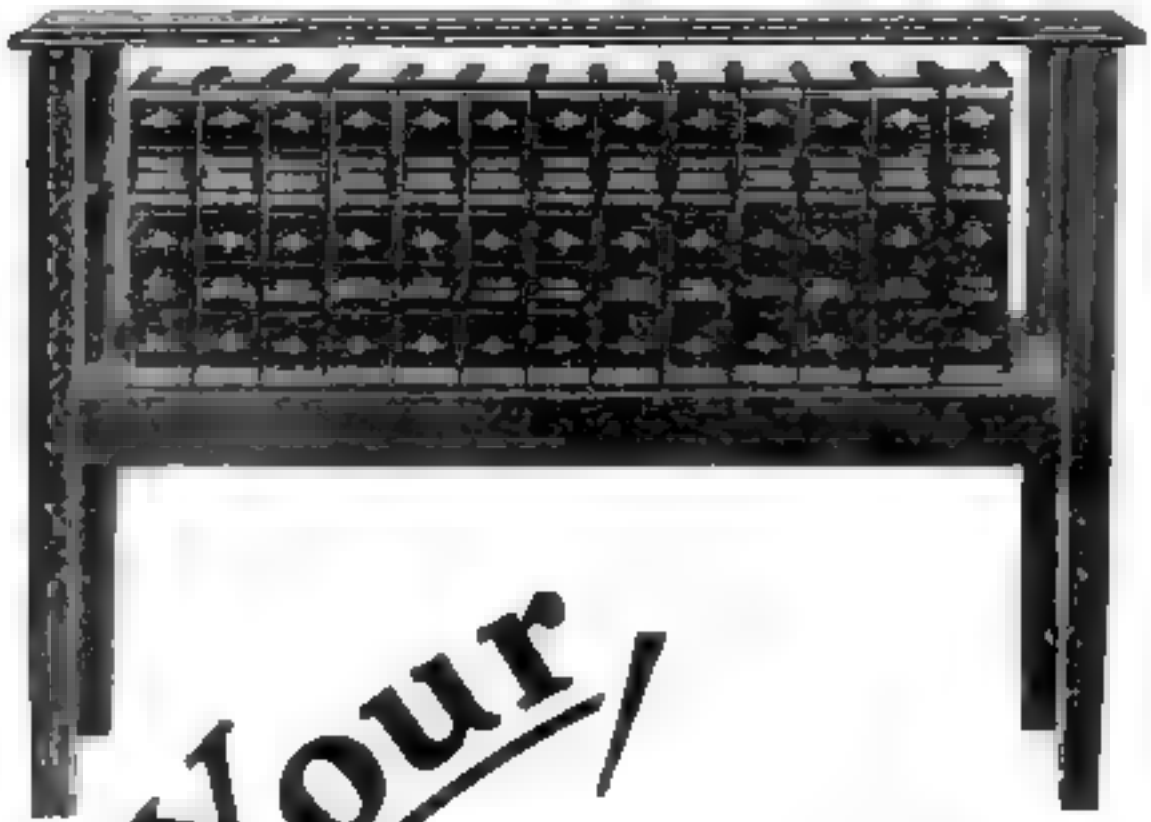


Fig. 2. The cross section and the views above it clearly show hull construction and method of fitting the decks



★ Let Nelson's help improve your leisure hours. The habitual use of this wonderful Encyclopaedia means a broadened intellect—wider and deeper knowledge upon every subject investigated—skill in discriminating between facts and theories—the development and strengthening of a logical mind which enables you to grasp larger things in life! In all your daily undertakings, "BE SURE YOU ARE RIGHT—THEN GO AHEAD." Check up your facts with Nelson's!

Because of the patented Loose-Leaf binding device, every fact you get from Nelson's is not only authoritative but *always up to date*. The ONLY encyclopaedia of which this is true!

Your Progress depends upon Your use of Your spare time★

What you Get in Nelson's Loose-Leaf Encyclopaedia...

A handsomely bound, beautifully printed encyclopaedia that is new now and will always be up to date. More profusely illustrated than any other encyclopaedia.

Authoritative articles on every conceivable subject . . . Biographies of prominent men and women—both of today, and the past . . . A complete Atlas of the world, including up-to-date maps and population statistics

New information that can always be substituted for obsolete matter by means of the exclusive loose-leaf binding device

An Index Volume, containing over 200,000 references—so exhaustive that every item, relating to any subject can be found instantly

Nelson's FREE Reader's Guide—39 full study college courses on as many subjects

FREE Membership in "Nelson's Research-Library Service-Bureau" for special information on any subject old or new

THE ENCYCLOPAEDIA FOR A LIFE-TIME

USE your spare time—if only a few minutes a day—acquiring valuable information to know the world in which you live. Don't guess—know the facts!

Knowledge of facts means time saved and mistakes avoided. Facts are the keynote of every truly successful career—wisdom in a larger sense is founded upon facts!

Get *your* facts from Nelson's—and know that every one is correct, *right down to date!* Remember, the value of an encyclopaedia depends on its up-to-dateness; and fast-bound encyclopaedias must necessarily be *out of date always.* Nelson's *Perpetual Loose-Leaf* Encyclopaedia is ALWAYS UP TO DATE—it never grows old!

This great American Encyclopaedia is considered an authority—in the Library of Congress, U. S. Senate, U. S. Supreme Court; in libraries, universities and schools in every State in the Union; and in thousands of homes

From the dawn of history to the present day, every field of knowledge is covered. Every article is clear, concise, authoritative—prepared by an expert. And Nelson's patented *Loose-Leaf* binding device keeps every article—every individual fact—correct, *right down to date.*

Nelson's is the only encyclopaedia with this vital feature—it changes and grows as the world progresses—it really LIVES!

You will find below a coupon that will bring you a book of beautifully illustrated sample pages including many pages showing illustrations and maps in full colors. Also this coupon will bring you full details about free membership in Nelson's Research Library Service Bureau and the Free Reader's Guide Service

NELSON'S *Perpetual Loose-Leaf* ENCYCLOPAEDIA & Research Bureau for Special Information

Mailing the coupon puts you under no obligation. May we tell you more about Nelson's Encyclopaedia? Why not mail the coupon today?

Mail Coupon NOW!

THOMAS NELSON AND SONS,
381 Fourth Avenue, New York
Send me Free, your Book of Specimen Pages with full information of your offer telling how I can own Nelson's Loose-Leaf Encyclopaedia on the Small Monthly Payment Budget Plan.

Name .....
Street .....
City ..... State .....
P. S. Dec. 2

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

A Simply Made Push Sled for Baby

By Roy W. Marsh

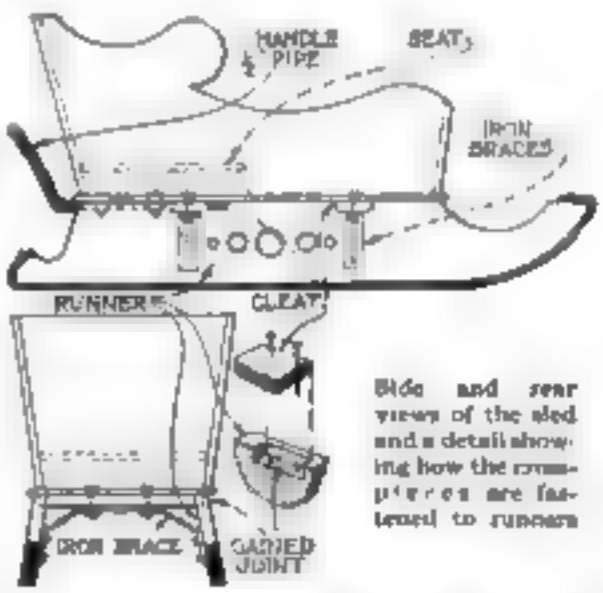
Unlike many push sleds, this requires little skill with tools to construct satisfactorily

A BABY'S push sled can be constructed with little difficulty by any handy man who follows the general method of construction illustrated.

The wooden parts required are two pieces ⅝ by 6 by 30 in. for the runners, 1 piece 1½ by 14 by 24 in. for the floor, 2 pieces ⅝ by 12 by 20 in. for the sides, 1 piece ⅝ by 12 by 15 in. for the back, 1 piece ⅝ by 6 by 15 in. for the front and 2 pieces ¾ by 2 by 12½ in. for the cross braces.

The handles were made of ¾-in. gas pipe about 52 in. long. The ends were flattened where they run under the sled and bolted through the crosspieces and the bottom. The cross bar was a piece of rake handle 18 in. long with ¾-in. holes bored 1½ in. from each end to receive the ends of the gas pipe. These were fastened with rivets.

The runners should be shod with iron. Use ⅛-in. or ¼-in. strap iron ⅝ in. wide,



Side and rear views of the sled and a detail showing how the crosspieces are fastened to runners

or if you prefer, use cold rolled stock of half-round cross section. Be sure to countersink the screw heads.

A removable seat about 9¼ in. high was made to fit inside the sled. The seat and the floor are covered with bound sample patches of carpet obtained for nothing at a carpet store.

The ornamental holes in the sides of the runners are ⅜, 1 and 1⅝ in. in diameter. The finish in this case was gray brushing lacquer of a kind guaranteed to stand outdoor exposure, but automobile enamel or any other durable finish could be used

Silent Magic

Here is the Eveready Layerbilt "B" Battery No. 486, Eveready's longest-lasting provider of Battery Power.

Radio is better with *Battery* Power

TURN your radio dial, and presto! you turn your home into a theater, a concert hall, a lecture room, a cabaret, a church, or whatever you will. Turn the dial and your attentive ear does the rest. That is all there is to this magic of radio.

Or almost all. If a radio set is to work at its very best, attracting no attention to itself, creating for you the illusion that can be so convincing, you must pay a little attention to the kind of power you give it. There is but one direction, a simple one—use Battery Power. Only such power is steady, uniform, silent. It is called by scientists pure Direct Current. Any other kind of current in your radio set may put a hum into the purest note of a flute, a scratch into the song of the greatest singer, a rattle into the voice of any orator.

Don't tamper with tone. Beware of interfering with illusion. Power that reveals its presence by its noise is like a magician's assistant who gives the trick away. Use batteries—use the Eveready Layerbilt "B" Battery No. 486, the remarkable battery whose exclusive, patented construction makes it last longest. It offers you the gift of convenience, a gift that you will appreciate almost as much as you will cherish the perfection of reception that only Battery Power makes possible.

EVEREADY
Radio Batteries
—they last longer

NATIONAL CARBON CO., INC.
New York UCC San Francisco
Unit of Union Carbide and Carbon Corporation

Tuesday night is Eveready Hour Night—9 P. M., Eastern Standard Time

WEAF—New York
WJAR—Providence
WEEI—Boston
WCAU—Philadelphia
WGR—Buffalo
WCAE—Pittsburgh
WSAI—Cincinnati
WTAM—Cleveland
WWJ—Detroit
WLS—Chicago
WOC—Davenport
KSD—St. Louis
WCCO—Minneapolis, St. Paul
WDAF—Kansas City
WRC—Washington
WGY—Schenectady
WHAS—Louisville
WSB—Atlanta
WSM—Nashville
WMC—Memphis

Pacific Coast Stations—
9 P. M., Pacific Standard Time
KPO—KGO—San Francisco
KFOA—KOMO—Seattle
KFI—Los Angeles
KGW—Portland

The air is full of things you shouldn't miss

Restoring Antique Furniture

An Expert Repairer of Old Pieces Reveals His Secrets—How to Preserve the Original Patina

By R. C. STANLEY

Many old pieces of furniture stored in attics can be returned to service as valuable antiques if they are properly repaired and restored

IN THIS day of the "antique craze" a great many amateur mechanics are attempting to repair and refinish old furniture. To these I shall endeavor to impart some of the knowledge gained through long experience in this work. What I write is not merely personal opinion, but includes a lot learned from others and now used in my own shop.

The first and most essential thing to know is what constitutes antique value. This, of course, is the appearance of age. Destroy the old look and the value of the piece as an antique is destroyed. What gives wood its appearance of age is a change that comes over the surface after long exposure. The popular name for this appearance of the surface is "patina." Diluted nitric acid is sometimes employed to give wood an artificial patina. The treatment is unsatisfactory, however, as there is nothing natural about the film's appearance.

IN SOME pieces of furniture the name of the famous old maker gives them their value, but the ordinary piece, such as most of us own, derives most of its value from its original patina, hence the importance of preserving the surface in its original state.

Now that we understand the necessity of preserving the patina, we shall see how shellac, varnish, and other finishes may be removed, leaving the patina intact. But first let me insert a few don'ts:

Don't plane the surface to be preserved, don't do any indiscriminate and hurried scraping, don't use any solution containing concentrated lye; don't start work until you have given it a very thorough examination to determine its needs, for it will be found that every job of this kind is different from every other one, don't, after the job is started, try to hurry it—if you feel impatient to have the job done, dig some bait and go fishing.

THE patina has the same color in all woods, and the older the piece, the more marked it becomes. It is recognized by its smooth, mellow, yellowish tinge but it is transparent. To those who do not recognize this surface condition, it is almost impossible to describe it unless one is looking directly at an old piece; then, of course, it can be shown and does not have to be described.

To remove old finishes of paint and varnish, always use a good grade of paint and varnish remover. Apply the remover generously with a brush, but do no more brushing than is necessary. The coating absorbs the remover and becomes soft. Leave it for a sufficient length of time, which varies according to the thickness and nature of the coat to be removed. This may be determined by scraping spots the size of a dime. When the action is found to be complete, remove the finish from flat surfaces with a dull scraper, a

(Continued on page 187)

Tycos, the Sixth Sense Saves Money and Insures Quality

IN MAKING shoe leather accurate temperature regulation is essential if the plate in the hydraulic press is too cold the work has to be done over; if too hot the quality of the leather is impaired.

One manufacturer of shoe leather has increased his production, improved quality and saves $936 annually by using the scientific accuracy of *Tycos*, the Sixth Sense of Industry instead of the guess work of old methods. And through the use of *Tycos* Instruments for indicating, recording and controlling temperatures this manufacturer has insured absolute uniform quality for his products.

In these days of mass production and heavy competitive selling *Tycos* Instruments insure an absolute uniformity of heat treated products that is essential to success.

Whatever you make if your manufacturing problems require the indicating, recording or controlling of temperature, there is a type and style of instruments in the *Tycos* Line of 8,000 varieties that will help you. Informative literature on any type of instrument will be sent you promptly on request. Or our engineer will consult with you on the application of *Tycos* to your particular manufacturing problem.

Tycos for the Home

***Tycos* Office Thermometers**
An aid to promoting human efficiency

***Tycos* Bath Thermometers**
To enable you to get the most good from your bath.

***Tycos* Home Set**
Bake Oven Thermometer. Candy Thermometer. Sugar Meter. The secret of accurate results in cooking.

***Tycos* Wall Thermometers**
To help you maintain a temperature in your house conducive to good health.

***Tycos* Quality Compasses**
To show you the right way in unfamiliar country

***Tycos* Fever Thermometers**
A necessity in every home.

***Tycos* Storm-glass**
Forecasts the weather twenty-four hours ahead with dependable accuracy

***Tycos* Hygrometer**
To enable you to keep the humidity of the atmosphere in your home correct at all times.

Tycos for the Medical Profession

***Tycos* Sphygmomanometer, Pocket and Office types.**
***Tycos* Urinalysis Glassware.**
***Tycos* Fever Thermometers.**

Your dealer will show them to you. Ask us, on a postal, for booklets on any of the above

Write for Bulletin

Taylor Instrument Companies

Main Office and Factory
ROCHESTER, N. Y. - - U.S.A.
Canadian Plant 95 BUILDING, TORONTO
SHORT & MASON, Ltd. Manufacturing Distributors in Great Britain

THE ~ SIXTH ~ SENSE ~ OF ~ INDUSTRY

Tycos Temperature Instruments

INDICATING - RECORDING - CONTROLLING

Hints on Laying Out a Home Workshop Compactly

By A. W. Woehr

Fig. 1. Bench for woodworking, storage shelves, movable droplight and tool racks

THROUGH the installation of an oil burner, the coal bin space in my cellar became available for a workshop. At small expense I converted it into the shop illustrated. There is a space of about 3 ft. in front of the benches.

The general arrangement is shown with sufficient clearness in the illustration, but there are two or three features which may be mentioned, as they may appeal to other home workshop enthusiasts who have not adopted corresponding devices.

Where one has a long shelf over a bench a handy and readily moved droplight may be fashioned in a short time from a few pieces of wood, as shown in Figs. 1 and 3. The advantages are that the light may be quickly moved to any part of the bench and the height can be regulated.

One of the best arrangements I have found for keeping tacks, brads, nails, staples, screws and a hundred and one other small odds and ends is also illustrated in Figs. 1 and 3. A number of empty mayonnaise jars of various sizes are collected and cleaned and the labels removed. These glasses form ideal containers, because the contents can be seen at a glance and in most cases no identifying labels are necessary. The covers with

Fig. 2. Bench for lathe, drill press and grinder. The motor is underneath the far end

their paper pads close so tightly that they protect the contents from moisture.

A rack for keeping these jars in an orderly fashion may be made like that illustrated. A small strip of wood about ¾ by 1½ in. is placed in front of each shelf to keep the jars from sliding off.

Over the benches in Figs. 1 and 2 are shown tool racks which can be removed bodily from the wall. This is better than hanging the individual tool holders directly on the wall because of the work it saves if the shop has to be moved or rearranged. The cups for chisels, files, screw drivers and similar tools are patented tool holders obtainable in hardware stores, while the holders for hammers, shears, saws and the like are straight hooks or cup hooks. These are fastened to strips of wood, which in turn are fastened to the wall.

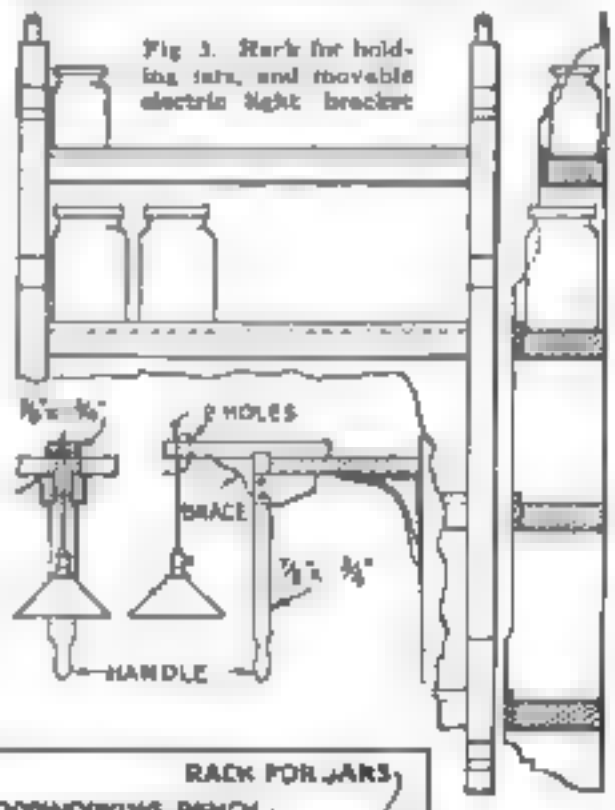


Fig. 3. Rack for holding jars, and movable electric light bracket

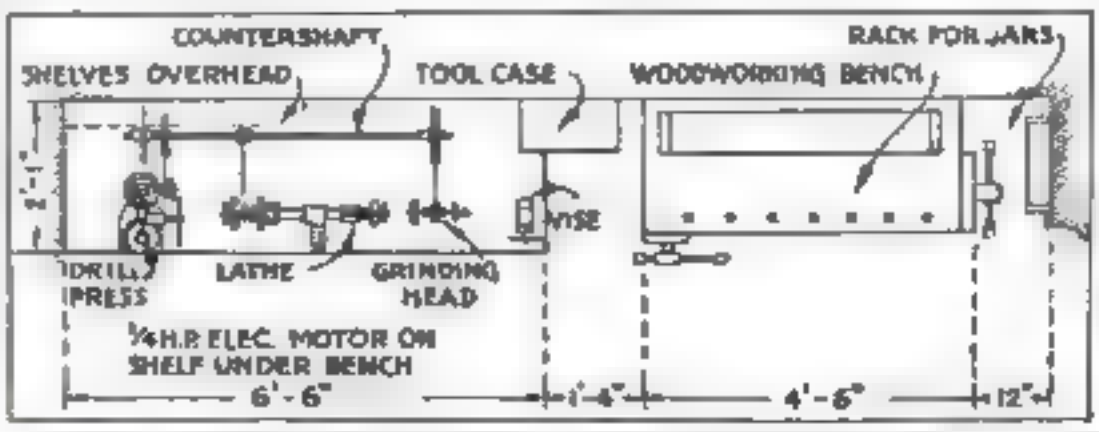
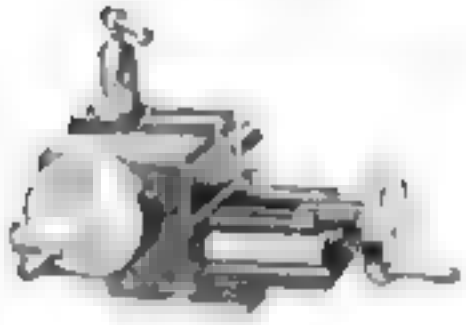


Fig. 4. Plan view of workshop in cellar

A *reliable* BENCH LATHE at a price you can afford

No. 125—$40



No. 132 Slide Rest
List $17.50

IF you don't require ultra precision, but do want a reasonably accurate lathe, this one will serve your purpose and meet your pocketbook.

This lathe is sturdily built and dependable, and is designed especially for use in trade schools, repair shops and the home work shop.

It has Milled Bed and Tail Stock with Milled Base, both Screw and Lever Feed and 3-Step Cone Pulley. Capacity: 7" swing; 12" between centers. Live Spindle fitted with cone bearing. Measures 25" over all and is 11½" high.

No. 125 . . . . List $40.00.

No. 494 Bench Lathe is similar, but has larger T Rest and longer bed. Capacity 7" swing; 18" between centers. List $44.00.

Either lathe can be driven by a ¼ H.P. motor.

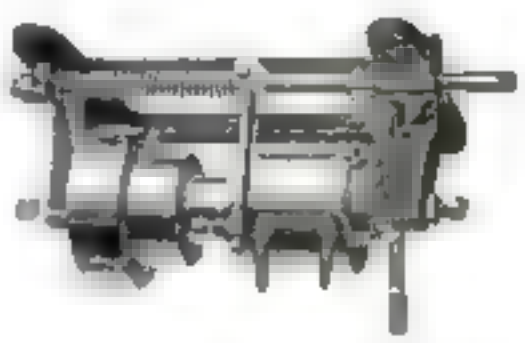
Ask to see these Lathes and Accessories at your dealer's. Or write us for Lathe Booklet, which will be sent FREE on request.

GOODELL-PRATT COMPANY, GREENFIELD, MASS., U. S. A.

MAKERS OF Tool-smiths, NOT PUNCH

No. 128 Turret Attachment. List $50.00

No. 194 Saw Table
(saw not included)
List $17.50



No. 130 Countershaft
List $12.00

GOODELL-PRATT

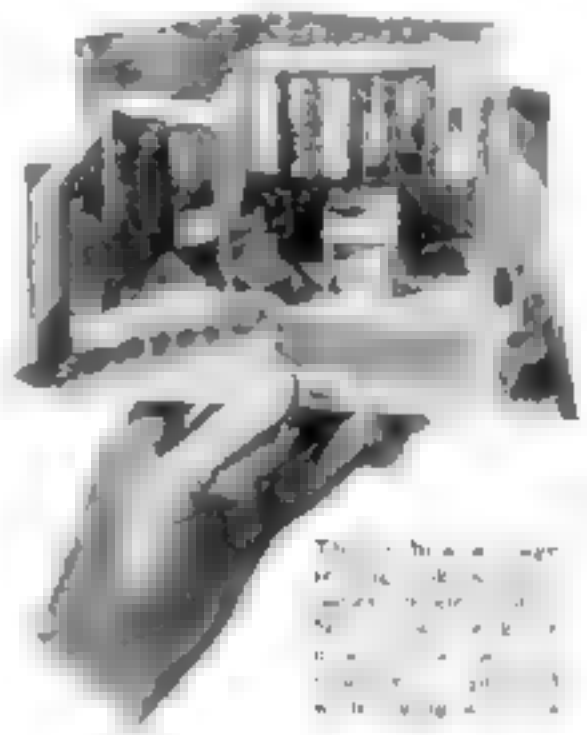
1500 GOOD TOOLS

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS See page 6.

Paper Models Help Design Amateur Stage Settings

By ANDRE SMITH
Author of "The Scenewright"

Second of a Series of Articles on Amateur Theatrical Scenery



IN THE first article of this series Jerry, the stage carpenter, was introduced to you as one of the most important members of an amateur play producing group. I showed him up in all his three-way glory, that is, as the designer of the sets, the builder of them, and, more often than not, the man who has to paint them. This triple personality has been called by the all-inclusive name of "scenewright," and for convenience of designation I shall hereafter refer to him by this dignified title.

Since in these articles my object is to introduce the amateur scenewright to the three divisions of his work, suggest to him the possibilities of his job rather than the full scope of it, I had best begin at the beginning and show you the scenewright in the first phase of his work: as the designer of sets.

If the scenewright happens to have had any sort of training as a draftsman, especially an architectural draftsman, his job as designer will be comparatively easy. He will know then how to handle drafting instruments, the T-square, triangle, and the architect's scale (or rule), and be able to lay out his floor plans and make the working drawings" for his scene frames. But he need not have this special training in order to do the job; almost anyone with paper, pencil and a ruler can make the necessary drawings. Even if your drawings are a little sketchy and faltering in draftsmanship, you need only remember that a good setting can emerge from a poor drawing as well as from one that is neatly and carefully done. It is not the drawing that counts, but the idea that the drawing embodies.

When the scenewright's ideas are commonplace, the settings will also be commonplace. But if the scenewright has read the play carefully, thought about it talked it over with the director, made sure what will be needed not only to satisfy the exact requirements of the play but also to add the quality of "atmosphere" to his sets, he will be certain to create something above the ordinary, a setting worthy of the attention of even a critical audience. And some night when the curtain goes up on one of his sets, and even before a word is spoken, he will hear the audience break into applause and know then that his thoroughness has not been in vain.

So I shall assume that all scenewrights are willing to give that "overtime" quality of thoroughness to their work that makes for success. In that case the scenewright won't be satisfied merely to make a plan of his sets and draw up the side walls or boundaries, but will want to follow up his drawings with a model. He may at first think this an unnecessary addition to his labors. As a matter of fact it is quite the opposite, it is labor-saving in that it gives the scenewright (as well as the director and actors) a chance to see the settings in miniature, to visualize the background of the play before the actual sets are built. It allows also for changes and modification in the sets while these changes are still easily made, that is, in the model instead of the actual sets. And the model also gives the scenewright and his assistants the assurance of the outcome of their labors. They realize that instead of working from more or less mysterious drawings, they need only to enlarge the model to full size and the job is done. In brief, the model allows them to see "where they are at" to know what is expected of them and why.

I cannot stress this point too much since I have tried both methods, without a model and with a model, and the model method is always the better in every way. The model stands ready at all times to settle doubts and arguments. If a question arises about the building of a certain frame in a certain way, the answer is to be found in the model. And later, when the frames are made, covered and painted and are ready to be set up, the model again shows even better than a plan or a sketch how the various frames are to be joined, the angles of the walls, and other details of alignment.

Now a model can vary from a strip of paper folded in such a way as to show the corners of the room, with windows and doors roughly sketched in, to an elaborately-drawn, painted and furnished creation. The degree of elaboration is entirely up to the *(Continued on page 92)*

$55.

At this price the Crosley Bandbox is Radio's most astonishing success, not because the price is low, but because the set is magic!

The ability of the new Bandbox is amazing. Its simple operation is easily understood and its wonderful performance is at the command of any hand that can turn the dial.

Millions are making up their minds today to buy a radio.

Millions will replace obsolete sets with new up-to-date receivers this year.

Experienced radio owners will look first for 3 fundamental points and in every set they consider will address these questions

1. Is it selective?
2. Is it sensitive?
3. Is it easy to operate?

Satisfied on these points they will look for

4. Genuine tone quality
5. Consistent performance
6. Moderate price

Millions will look at the Crosley Band box. This amazing set is now displayed by more than 20,000 dealers

This dealer array, experts say, will sell a million dollars worth of Bandboxes this season

Crosley dealers from Maine to California have this wonderful receiver hooked up for immediate demonstration and will explain its matchless performance on a basis not equalled by any other

The Crosley Bandbox is a 6-tube receiver

The circuit of this set is of the sensitiveness you would expect from a group of skilled engineers suddenly given the pick of the world's radio patents to work with.

Crosley has always given the radio world its biggest value for the dollar. Contemplate the perfection possible when the doors of the research and development laboratories of The Radio Corporation of America, The General Electric Co., The Westinghouse Co., The American Telephone & Telegraph Co., and the Hazeltine and Latour Corporations were thrown open

Licensed under their patents!

Tremendous! Wonderful! Significant!

Surely it means that millions will possess the best radio performance possible at the low prices for which Crosley is already famous.

The Crosley Bandbox is totally and completely shielded. Every element is absolutely separated from every other element by a solid shielding. Coils are covered with copper. This result have been done cheaper but efficiency would have been sacrificed. Tuning units are housed in nickel-plated steel. All wiring is separated and shielded from all other parts of the receiver. Solid, sturdy, a Bandbox the entire set is assembled on a heavy metal chassis.

The tuned radio frequency amplification stages have been shielded nearly to space through use of the Neutral principle. The set is a genuine Neutrodyne!

To the initiated this means much. To the layman it manifests itself only as a set that receives distant and weak or local stations when you are trying not to get a station.

The intriguing answers for the Crosley Bandbox the three fundamental questions set forth in the fourth paragraph which the experienced radio owner is making of every set he sees this fall.

The shielding makes the Bandbox highly selective—the circuit delicately sensitive and the design extremely easy to operate.

The Bandbox is operated with a single station selector tube dial

In most localities and in most owners' hands the single station selector will find all the broadcasts all one could possibly wish. But there are some owners who demand greater ability like the possessors of 80 horse power motor cars who may never step on it but like to be conscious it's there. For such have the Armfelt-Hazeltine tuned amplifiers. By a few degrees of weak power but perhaps great music are captured by the use of these little accessory tuners. These 2 controls is best likened to a pair of fish glasses. As the boat nears the distant scene to nearby aspect, so do the accessories bring the remote station

outside up to room-filling volume. Ordinary one-dial radios can never permit such refinements. Their one knob or two knobs together to shift in about the broadcasters. But we are ready to demonstrate to doubters that the Bandbox a substantial overhaul of the air and all that is in it

The dial of the Bandbox is illuminated. A detail! A refinement added but not to an excuse to raise the price. But shadowy rooms and dim evenings it recommends itself

Volume Control is necessary on good radio today. Nearby and high-powered broadcasting must receive into its range. The thing has been a favorite method of subduing the loud speakers but with millions closer and closer together on the dial defining particularly in large cities stations in overlapping of programs. The ear has the eye in only good for one thing at a time. Under the powers of the best loud speakers the volume control of the Bandbox cuts the loudest blast down to a veritable whisper. No distortion whatsoever!

A single [illegible] outside and power connections from the Bandbox. In this respect is the power cable has earth and ground with current rather the protection, precision and easy assembly. This connection applies to it.

The adaptability of the Bandbox to installation is all [illegible] a feature. The metal cover of the Bandbox lifts off the chassis. This leaves the dandy shingled dial which and [illegible] to fit be stuck through holes in the panel of any kind of cabinet. The installation is [illegible] complete and the console installations is not only complete but has no elements of a makeshift.

Much has influenced the $55 price of the Bandbox.

First, an ideal and an idea.

Then, a working out of the idea.

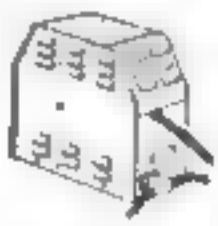
And now the constant pounding of the ideal.

Back but we radio became the entertainment "hour it is today Powel Crosley, Jr. held an ideal that the things which give pleasure should be made to sell at low prices so that millions may enjoy them.

When radio was a bundle of hairpins turned with the Bandbox this hypothesis remains to be the idea that it up could make radio in sufficient quantities be sold supply millions with a means of enjoying this new source of pleasure at moderate prices.

Every radio year has been a year of rapid production engineering by Crosley. This year with an investment of over half a million dollars in equipment that a fine radio might be made at high speed and in such quantities that a price of nearly half a hundred dollars could be maintained.

Throughout the country millions examine the Bandbox today. They see in the achievement of an organization who began the development when radio as we know it today began. Its success has been tremendous if clamorous demands from dealers are any indication. Shop-



Power Converter $60

The new R C A. AC tubes provide clear smooth and pure reception equipped to in every way to the most efficient wet storage battery power.

Alternating current ripple is eliminated out in the miniature little power unit which is called the A. B. Bandbox. This device now is so efficient in its [illegible] the size of an ordinary storage battery and enables the Bandbox to think and [illegible]

The AC Bandbox is $65

The Power converter is $60

This gives you a complete direct A. C. set adaptable to any place of that but in the any choose. Bookcase, console, desk cabinet are chosen or tuck it away on the corner of the table. [illegible]

THE CROSLEY MUSICONES ARE AS OUTSTANDING IN THE R. FIELD AS THE BANDBOX IS IN ITS

Back in early 1925 radio's audibility above the static interference was still depended upon a horn. Unnatural and harsh it was a handicap on a fast developing industry. Then at great cost might the limitation be surmounted. Suddenly Crosley offered the radio world a cone speaker at $[illegible]. Instantly the demand exceeded the supply. Promptly loud speaker sales were gauged by the leadership of the Musicone.

Today that position is still maintained. The cause is plain. Mechanical refinement and improvements of the Musicone since its inception have been constant and considerable.

Price of the Musicone have shown a steady downward trend from $17.50 in 1925 down to $8.75 at the present time.

Only a national acceptance could make this possible and only a remarkable value could create such a national acceptance.

Today the Musicone is a perfect reproducer through –

1. A new metallurgical discovery giving many times the vibrating capacity of the actuating unit of formerly
2. Bakelite coil cover impervious to moisture.
3. Sextuply coated wire that does not permit deterioration in damp climates.

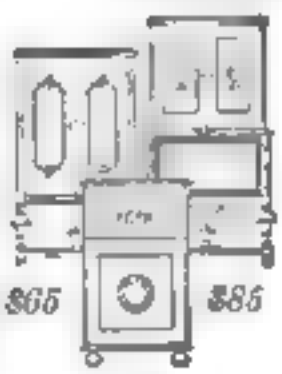
Crosley owners find a perfect affinity between the Bandbox and the Musicone aside from their physical appearance

The Musicone is sold in two sizes.

The Chief Musicone 12-inch ... $8.75

The Super Musicone, as illustrated, 18-inch ... $13.75

APPROVED CONSOLES



"I want the public to have as great a value in cabinets this year as I have given them in the Bandbox," said Powel Crosley, Jr.

Prominent furniture manufacturers with their long experience produced beautiful cabinets at moderate prices. Designs, cabinet set were approved, passed, retail, approved! The Musicones were built in. Crosley dealers now sell them. Purchasers may know they are best suited for Crosley radio by looking for the "approved label" in each one. Crosley dealers get these cabinets ship from The H. T. Roberts Co. located at 3454 S. Stephen Ave. Chicago. Sales representative for The Roberts Brothers Co., Bloomington, Ind. and The Wolf Manufacturing Industries, Kokomo, Ind.

Write Dept. 17 for descriptive literature

CROSLEY RADIO

THE CROSLEY RADIO CORP.
Powel Crosley, Jr., Pres.
Cincinnati, Ohio

Crosley is licensed only for Radio Amateur, Experimental and Broadcast Reception.

Montana, Wyoming, Colorado, New Mexico, and West prices slightly higher.

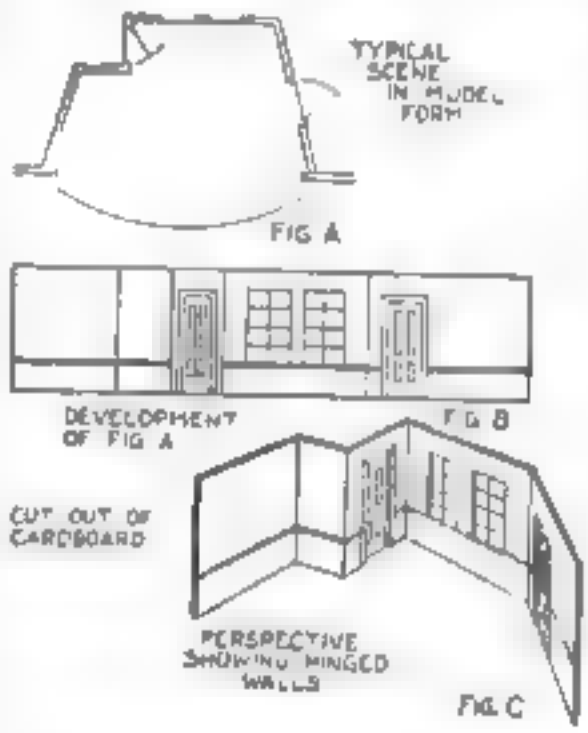
This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Paper Models Help Design Stage Settings

(Continued from page 80)

scenewright. If a rough model is all he needs to help him visualize his finished sets, well and good if he wishes to enjoy the satisfaction that comes from any job well done, I urge him to make his models with considerable care. This additional effort is sure to be reflected in the actual finished sets. They will look as if they were designed rather than just thrown together. They will possess a structural quality and finish.

If you will look at the accompanying diagram you will see the development of a model in its very simplest form. A shows the stage and the floor plan of the room; B, a development in elevation of the three walls; C, how these walls will



The three preliminary operations in designing a stage setting. The finished paper model is worked up from these drawings

look when cut out and folded according to the floor plan. All models of interior sets are based upon this principle of working from a floor plan, by way of the developed side walls, to the folded "room." To insure accuracy these three walls can be set up on the drawing of the floor plan, but this is helpful only in an elaborate interior where the walls have unusual recesses or projections, or must slope at a particular angle.

If our student scenewright will now take the trouble to make a model box, drawing it to scale with the stage for which he is designing his sets, designating especially the width and height of the proscenium opening before cutting it out, he can then pave his model set to this box and see how the sets will appear later when, by the magic of enlargement and a little hard work, they will stand actually on the real stage. For that reason and in order to make certain of his visualization and the outcome of his sketches, he should make his model as nearly as possible a miniature of the finished sets. This is especially true in the case of the beginner

In making a model the most convenient scale at which to work is one half inch to the foot. The paper (Continued on page 189

A Hint to Those with Pipe-Smokers on Christmas Lists

The following letter may prove to be a Christmas tip to those who have pipe-smokers on their Christmas lists

Carney's Point, N. J.
January 7, 1927

Larus & Bro. Co.,
Richmond, Va.
Gentlemen:

My son noticed your advertisement in a magazine. He sent for the sample in my name, and when the sample of Edgeworth arrived I thought perhaps some friend had sent you my name.

The boy questioned me several times whether I liked the new pipe tobacco. When I told him I liked it better than any I had ever used, he surprised me by giving me a one-pound box for Christmas.

I might say that I do not hear any complaint from my wife any more about the pipes.

Very truly yours,
James L. Vaughan

The two favorite gift sizes of Edgeworth are the 16-ounce glass humidor jar and the 8-ounce tin. Both are provided at Christmas time with appropriate wrappings. Each size contains Edgeworth Ready-Rubbed, and each is packed in a good-looking decorated gift carton printed in colors. Prices—$1.65 for the 16-ounce jar. The 8-ounce tins are 75¢ each.

Please ask your tobacco dealer for the Edgeworth Christmas packages. If he will not supply you, we gladly offer the following service to you

Send us $1.65 for each 16-ounce jar and 75¢ for each 8-ounce tin to be shipped, also a list of the names and addresses of those you wish to remember, with your personal greeting card for each friend.

We will gladly attend to sending the Christmas Edgeworth to your friends, all delivery charges prepaid.

Personal: Perhaps you yourself are not acquainted with Edgeworth. If so, send your name and address to Larus & Brother Company, 10 South 21st Street, Richmond, Va. We shall be glad to send you free samples—of Edgeworth Plug Slice and Edgeworth Ready-Rubbed.

Both Edgeworth Plug Slice and Edgeworth Ready-Rubbed are packed in small, pocket-size packages, in handsome humidors, holding a pound, and also in several handy in-between sizes.

To Retail Tobacco Merchants: If your jobber cannot supply you with Edgeworth, Larus & Brother Company will gladly send you prepaid by parcel post a one- or two-dozen carton of any size of Edgeworth Plug Slice or Edgeworth Ready-Rubbed for the same price you would pay the jobber.

[On your radio: tune in on WRVA, Richmond, Va., the Edgeworth Station. Wave length 254.1 meters, 1180 kilocycles]

A Joint You Can Take Apart

How to Make a Keyed Mortise and Tenon for Collapsible Furniture

By Emanuel E. Ericson

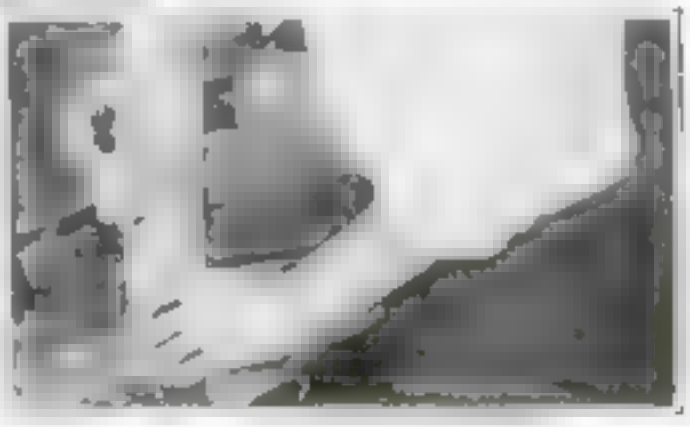
1 When laying out the length of the tenon in the lighter types of construction, a good allowance will be from 1¾ to 2 in. If this is more than is needed, the tenon can be cut later

2 (Below) Lay out the thickness of the tenon with the marking gage, always keeping the head of the gage against the working face of the rail. Run lines also on the ends of the pieces to facilitate sawing. Next lay out and mark the mortises in the mating members with extreme care

3 The tenon is cut exactly to the lines with a rip saw, as shown above

4 (Above) The mortise may be cut with a chisel, half from one side and half from the other, or an auger bit may be used and the holes trimmed up with a chisel

5 (At left) If the rails are from 2 ½ to 3 in. wide, make the key about 6 in. long and approximately half as thick as the tenon. It should taper in width from ⅛ to ⅜ in. Insert tenon through mortise, mark location of key as shown, and chisel a mortise for it



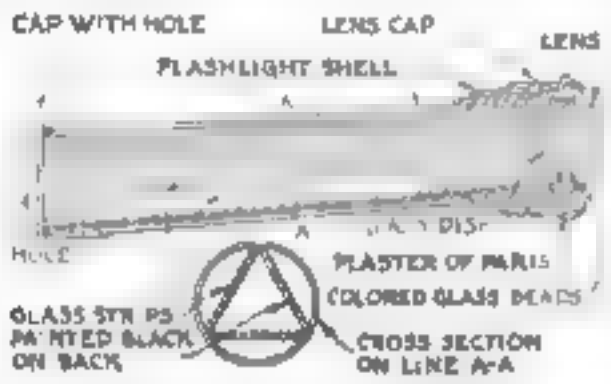
6 If properly fitted, the key can be pushed easily into place. Round off the ends of the key and either bevel or round the corners on the end of the protruding tenon. Other methods may be used for making this joint, but beginners will find it well to follow these steps

Kaleidoscope Made at Trifling Cost

AFTER vainly trying, in a city of half a million inhabitants, to purchase a kaleidoscope for my grandchildren, and failing even to get information as to how to construct one, I succeeded in making just what was wanted at the cost of a few cents. In years gone by the kaleidoscope was a familiar optical instrument or toy in which one could see reflected an endless variety of colored designs.

To make one, obtain a flashlight shell—one with a small hole at one end—and five cents worth of small colored glass beads at a ten-cent store.

Discard the reflector and the copper contact strip inside the flashlight shell,



Lengthwise section through the toy and cross section showing arrangement of reflectors

and remove the spiral spring that is fastened to the circular plate with a hole in it. After unscrewing the cap holding the lens, fasten the lens in the cap with plaster of Paris or some other cement. Then cut a circular disk of thin glass to fit in the cap over the lens.

Lay a single layer of the smallest and most highly colored beads upon the flat side of the lens, and place the glass disk over them. Now put the lens cap on the flashlight shell, but not so far as to interfere with the free movement of the beads. A drop of solder will hold the cap in place permanently

Cut three pieces of thin glass so that they will form an exact equilateral triangle, as shown, when they are inserted in the shell. Paint these black on one side and place them in the shell with the unpainted side facing inward. Screw on the cap with the black disk, which has the eyehole, and the kaleidoscope is made.—G. A. BAHN

How to Stripe Furniture

AFTER a number of unsuccessful attempts to stripe various small articles about my house with brushing lacquer in a striping brush, I tried an ordinary draftsman's ruling pen. The results were excellent. I find, too, that compasses can be used equally well.

The only precaution necessary, is to have on hand for cleaning the pens a small amount of the thinner recommended for the particular brand of lacquer in use. Unless they are cleaned frequently, the pens will become clogged.

Using the pens in this manner does not harm them in the least.—CHAS. W. HAWTHORNE, Jr.

How to Make a Tool Case

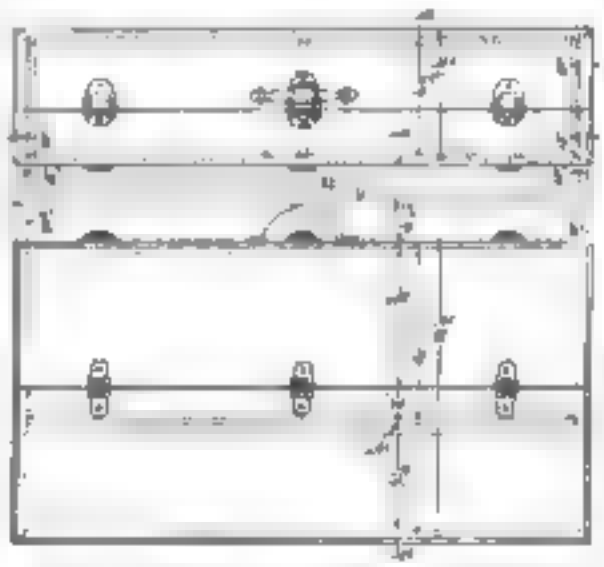
By J. C. EDDIE

THE popularity of this type of tool case is sufficient proof of its many merits. Although used primarily by the carpenter, it is a fine case for the handy man with his informal set of tools. Its ease of portability makes it useful even to the mechanic who

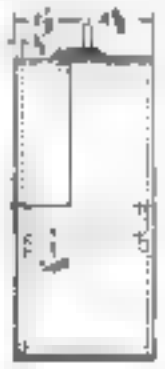
Every handy man needs a convenient and portable tool case for odd jobs

already possesses one or more large chests or cabinets.

The materials needed are: 1 pc. oak ¾ by 8 in. by 8 ft., 2 pcs. oak (3-ply) ⅜ by 10 by 30 in., 1 pc. white pine ⅜ by 6 in. by 6 ft., 1 tool box lock, 2 tool box clasps, 8 box corners, 3 hinges, 1 leather sample case handle, 42 No. 8-½-in. screws, round head, 40 No. 6-1-in. screws, round head, 28 No. 6-1¼-in. screws, round head, 2 doz. ¼ by 1 in. machine screws; 1 package twopenny brads. All hardware



Front and top views of the case and, at the right, the end view. Oak is the wood used



should be of solid brass.

Cut the 16 in. long end pieces from the ¾ by 8 in. piece of oak and the 31¼ in. long top and bottom pieces from the same stock. Rabbet the ends of the top and bottom ⅜ by ¾ in. as shown for the joints. Mark the end pieces and the top for the door and saw out with fine saws very carefully. Plane down the other pieces to make up for the saw kerf.

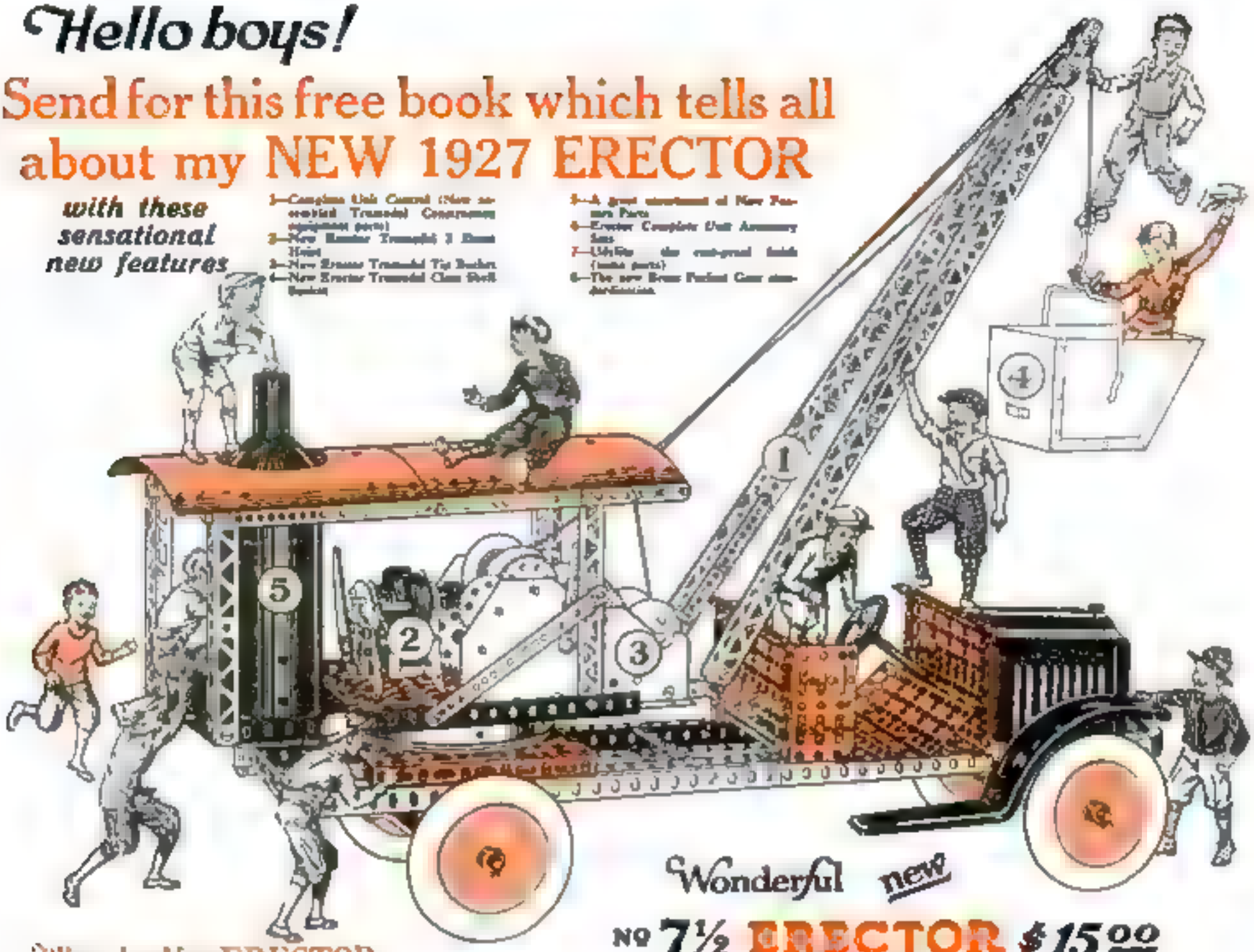
(Continued on page 99)

Hello boys!

Send for this free book which tells all about my NEW 1927 ERECTOR

with these sensational new features

1—Complete Unit Control (Now an erected Trumodel Construction equipment part)
2—New Erector Trumodel 3 Beam Hoist
3—New Erector Trumodel Tip Bucket
4—New Erector Trumodel Clam Shell Bucket
5—A great assortment of New Features Parts
6—Erector Complete Unit Accessory Sets
7—Ultra the end-grain finish (motor parts)
8—The new Erector Pocket Case construction



Why the New ERECTOR is the world's greatest toy

Trumodel Features:

1 ERECTOR SQUARE GIRDER. This big exclusive Erector feature makes Erector so sturdy and strong. There are real girders just like engineers use in making skyscrapers and bridges. In all Erector Sets.)

2 ERECTOR MOTOR. You can make 27 interesting experiments with the Erector Motor alone. The motor Shaft is the same diameter as all other shafts. You can hitch pulleys to both sides of the motor. (In the Famous No. 6 Erector and up.)

3 3-DRUM HOIST. Completely assembled operating unit. New exclusive Erector feature. In the No. 5 Erector and up.)

4 TIP BUCKET. An exclusive Erector feature. (In the No. 6 and up.)

5 ERECTOR STEAM BOILER. There is no end to the models that this exclusive Erector feature makes possible. Featuring engines, steam boats, fire engines, locomotive engines, steamrollers. The Erector motor furnishes power to make these models go. In the Super No. 7 and up.)

OTHER COMPLETE UNIT CONTROL PARTS MOTORIZED FEATURES ARE:

Large solid steel fire wheels with ballbearings, chassis, genuine fenders, hood, bumper, crank body, steering wheel, steering knuckle, front axle, springs. (All in the No. 7½ Erector and up.)

Other Erector Features

1. Erector contains more parts and builds more models than any other construction toy
2. The New Erector Beam Shovel—an exclusive Erector feature. (In the Super Erector No. 7 and up
3. The New Erector Bridge Builder—an exclusive Erector feature. (In the New No. 6)
4. Curved Erector Girders. An exclusive Erector feature. (In all sets.)
5. Giant Fly Wheel. An exclusive Erector feature. In the No. 10 Set.
6. Perforated Strips—four holes to the inch.
7. New beam permit easy standardization. The New Erector contains a great assortment of beam and flat-end plates, including pinion, crown gears, flat gears, slide plates and a large 57-tooth gear.

A FEW OF THE MANY NEW JIG FEATURE PARTS ARE:

Roller skate ball ring, new Chain Basket, Beam Girder Corner, Segment Plate, Bracket—and hundreds of other genuine perfect Erector-steel parts for building every engineering link ever attempted. Possible with no other toy than the New Erector.

1. Erector is made from structural steel, plated nickeled and absolutely lasting.
2. Designed by engineers, used by engineers and endorsed by engineers.
3. The Mechanical interest of Erector can not exhaust. It is the only system modeled on engineering lines.
4. Perfectly interchangeable, owing to the almost double of standardization.

With Automobile Chassis

Here's the set I know will give you the greatest thrill you ever had. Fun! Oh, Boy! It's the real thing, and there's a thrill packed in every one of its 627 parts. Boys, in this great outfit there are hours of real sport waiting for you building automotive models. From this great assortment of distinctive, important and feature Erector parts you can build 554 models—wonderful automobile chassis, tractors, scooters, service cars, fire engines, hook and ladder, are only a few

Packed in a cabinet and includes a complete assortment of automotive parts, many in colors; also a 92-page manual, powerful electric motor, big red steel disc wheels with oversize balloon tires, fenders, radiator hood, bumper, springs, steering wheel, truck body, heavy trunk axles, cab top, boiler, digger scoop—in fact, everything to make this out a world's standard.

Boys! Here's the greatest book I ever compiled

In this book you will find the final story of my years of experiment since I first invented Erector—the construction toy which other engineers have been kind enough to call "the world's greatest toy"—and which they consider one of the most astonishing mechanical phenomena of the age.

In this book I will you how with Erector's new Construction parts you can build and operate (one after the other) over 1000 actual working models of Aeroplanes, Submarines, Ocean liners, Light houses, Machine guns, Automobiles, Ship cranes, Trains, Steam shovels, Traveling cranes, Wrecking boat, Tunnel diggers, Locomotives, Hoisting derricks, Cantilever bridges, Suspension bridges, Well drillers, Power plants and Hoisting engines.

Think what a thrill you'll get making these wonderful working models while and later with the powerful Erector electric motor. The day you get your Erector (Christmas or any other day) will be the biggest of your life. Send for my new book "Engineering Thrills" today and then tell your Dad. Don't miss this chance. Make him realize what you really want by showing him the book and then taking him to the nearest toy store or see for himself. He'll want to build models with Erector too. Just fill out the coupon below.

A. C. Gilbert

Send for it—FREE

THE A. C. GILBERT COMPANY,
269 Blatchley Avenue, New Haven, Conn.

Please send me free my copy of the book "ENGINEERING THRILLS."

Name

Street

City *State*

Wonderful new

No 7½ ERECTOR $15.00

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Here is the workshop you have been waiting for! The DELTA Handi-Shop, a practical outfit for practical work. Big, sturdy, oversize attachments and accessories, and plenty of them. A trial will prove its true value.

Different? SURE!—Here's Why—

Make your favorite things and thousands of others in practically no time at all. The DELTA will do:

WE SET out to give you a really practical and efficient work shop. After long and careful study and experimenting, we scrapped all of the old conventional designs and ideas and decided upon using a sturdy quarter-h.p. motor of special design, with two shaft extensions—right there we had a valuable feature that offered unusual and practically unlimited possibilities.

While the motor-tipped Circular Saw is driven from one shaft, the Lathe with its many attachments can be driven from the other shaft. There are always two tools ready for work and ready controlled by a conveniently placed switch. Simply throw off the Special Rubber Velvet and the saw is disconnected. In a jiffy any one of the many full sized, sturdy, practical accessories is in place and you are ready to go. Simple isn't it? You never saw so big so easy-to-put-on convenient as the interchanging of attachments. You must try it to thoroughly appreciate its many advantages—its outstanding superiority.

The Delta Handi-Shop consists of the following—all specially designed and sturdily built from the finest materials obtainable:

Motor—Specially designed ¼ H.P. for current [illegible] R.P.M., constant speed, with two shafts.

Lathe—has capacity of 9" diameter x 2" [illegible]. Can be furnished up to 36" at small additional cost. Steel bed of I-beam section will not shatter or spring. Ball-bearing Tailstock. Four slots, split center, cup center and wide and narrow tool supports.

Lathe Attachments—6" diameter [illegible] grinding wheel, adapter flange [illegible] wire brush, all of finest quality all overseas. ½ capacity.

Jacobs chuck that fits both motor and tailstock spindles, two turning tools.

Sanding Attachment—6½" diameter "Manhasset" sanding disc. Takes standard sheet of sand paper. Novel design sanding table 11½" x 13" x 6" deep, 10" up. An exceptionally valuable and useful attachment, quickly attached and easily adjusted.

Flexible Shaft—Can be furnished in two sizes, with hand pieces to take standard burrs. Ideal for carving metal patterns and die work, etc.

Now—Give Yourself a Treat!

Make all those wonderful attractive things you want around the house. Develop your ideas and inventions. Get started in business—earn money in full or spare time. Let the DELTA HANDI-SHOP be your never-failing and faithful servant. Lack of space does not permit a full description here so act now—send for it and judge for yourself.

10 Days FREE Trial

A small down payment brings this complete workshop to you. Test it with those unusual things that only Delta Handi-Shop can do. You can do the simple things easier and quicker for. Let us send you our beautiful illustrated folder that describes in detail every novel and original feature of the DELTA HANDI-SHOP. See how much you get for so modest an outlay of money.

Mail Coupon NOW

FREE BLUE PRINTS

Delta Specialty Co.
Dept. MSP.—1227—[illegible] 3rd St.,
Milwaukee, Wis.

Send me your illustrated folder describing Delta Handi-Shop. Tell me about your Free Trial offer, free blue prints and easy payment plan.

Name

Street Address

City State

Dept. MSP

The famous New Model [illegible] American Circular Saw Bench. Has [illegible] Ball-bearing Motor. Saw blade supported under-neath table—an exclusive Delta feature.

Cutting a 1"x12" board at an angle. No interference. Rip and cutting-off guide. Limits to length of board handled.

Cutting grooves with dado head either at right angle or at an angle with table. Safety hot dog holds stock firmly against fence.

Sanding proper [illegible] on patterns, and doing and squaring electrotype. [illegible] of the many possible operations with this attachment.

Showing special frame for holding machine jeweler's blade for delicate marquetry or inlay work. Takes standard 6" long jeweler's blades. Note table is tilted fully 45° to the left. Blade also is securely supported by hardened guide underneath table.

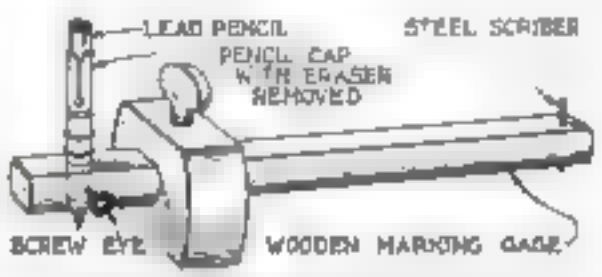
Showing small flexible shaft attachment. Note delicate work possible. Uses standard burrs easily obtainable everywhere.

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Pencil Holder Improves Marking Gage

FOR use in the home shop, an inexpensive marking gage may be improved by mounting a lead pencil at one end of the bar as shown. The pencil does not follow the grain of the wood when running parallel with it, as the steel point is apt to do, and the line is easier to see.

The holder is a long metal cap or point protector such as is sold with some pencils.



An ordinary marking gage with pencil attachment makes lines that are easy to see

The eraser is removed and the tube is pushed into a hole bored through the gage bar

A gage modified in this way is particularly useful in ship-model work and many other small woodworking operations, as well as for marking large boards which are to be rip-sawed into narrow widths.—E. T.

How to Make a Tool Case

(Continued from page 98)

Rabbet the long edges of the top, bottom and end pieces ½ by ⅜ in. to receive the ⅜ in. thick side panels flush. Glue up the top, bottom and end pieces and use three screws from both directions, being sure that the case is square. Square one side and the end of the side panels and cut them to size, then glue and screw them in place. One side, of course, will have to be cut out for the door.

Perhaps it will be best to leave the tray to the ideas and needs of the individual but it is made to rest on cleats placed on the ends and at the middle of the box so that its upper edge will be flush with the joint of the door. It should be a little narrower than the inside measurements of the box to allow room for the steel square, which will be kept in the back of the box.

Cleats should be arranged in the door to carry the saws. Hooks and other cleats can be installed for holding other tools.

Stain or merely oil the case with pure boiled linseed oil as preferred. When the wood is dry, use two coats of shellac rubbing each down with fine sandpaper. Follow with two coats of varnish (on the outside only), rub the first with fine sandpaper and leave the second as applied or rub it with fine powdered pumice and oil, according to whether a dull or glossy finish is desired. For a final, that can be applied more quickly, use stain, one coat of thin shellac, and two coats of high grade, clear brushing lacquer.

Mark the location of the hardware. Use the ½-in. round-headed screws for the hinges and corner clips and the ½ by 1 in. brass machine screws for the locks, snaps and handle. Rivet the inside ends to make it impossible to open the box merely by turning out the screws.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

LIGHT motor oil, or the lubricating oil sold as machine oil, has many uses in the home workshop. It can be used not only for lubricating machinery but also for polishing woodwork and protecting iron from rust.

To use the oil as a furniture polish for varnished and shellacked surfaces, first dust the surfaces with a soft brush or a piece of soft cloth. Then place a few drops of the oil on a clean rag and rub until the desired luster has appeared.

Machine oils of this kind may be diluted for polishing purposes with eight or ten times its volume of kerosene or gasoline. When gasoline is used, the mixture is, of course, highly inflammable and must be treated with respect. All open flames must be extinguished when the mixture is to be used. The effect of the diluting agent is to prevent an excess of oil being applied, which reduces the labor and also the likelihood of the surfaces being left so oily they will collect dust.

This oil polish should be well rubbed into the surface and any excess must be removed, preferably with a clean, soft rag. Then the wood can be further rubbed to bring out the finish.

While the recommendation is often made that the oil be applied on a damp cloth, I prefer to use a dry rag for polishing. If the rag is moist, one never knows when sufficient oil has been used. A surface to which the oil is applied with a wet rag will have a higher polish while the surface is covered with a film of water than when the film of water has evaporated. Quicker results are obtained by using a dry rag moistened with oil and then rubbing with another dry rag to remove any excess of oil.

WHEN the wood is dirty, the varnished and shellacked surface may be wiped with a cloth wrung in warm, slightly soapy water. The soap used should be a very mild one, such as castile. Wipe the finish dry at once and then polish with the oil.

If, after being cleaned, the surface appears badly worn, the varnish may be improved by rubbing it with floor wax.

Applying thinned light motor oil to iron or steel parts prevents rusting.

When oil is moist or contains water the water may be easily removed by filtering the oil through salt. Take a large funnel, add the usual piece of filter paper and half fill the filter paper with ordinary table salt. Pour the moist or watery oil on the salt, the dehydrated oil will flow out at the bottom, while the salt will hold the moisture. Running the oil through salt once is usually sufficient.

To remove a rusted screw, place a drop of oil on the screw and apply a hot soldering iron to the head. Add more oil and repeat the process if necessary.

Blueprints for Your Home Workshop

ANY ONE of the blueprints listed below can be obtained for 25 cents. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available.

POPULAR SCIENCE MONTHLY
250 Fourth Avenue, New York

GENTLEMEN:

Send me the blueprint, or blueprints, I have underlined below, for which I inclose .....dollars.....cents:

No.	Title	Date and number of issue	Price
1.	Sewing Table	Feb., '22	25c
2.	Smoking Cabinet	Mar., '22	25c
3.	End Table	Apr., '22	25c
5.	Kitchen Cabinet	May, '22	25c
8.	Shaving Cabinet	June, '22	25c
9.	Arbor Gate and Seats	July '22	25c
10.	Porch Swing	Aug., '22	25c
11.	Bench and Tilt Table	Sept., '22	25c
12.	Electric Washer	Oct. '22	25c
13.	Tea Wagon	Nov., '22	25c
14.	Christmas Toys	Dec., '22	25c
15.	Workshop Bench	Jan., '23	25c
16.	Inland Radio Cabinet	Feb., '23	25c
17	Cedar Chest	Mar '23	25c
18.	Phone Table and Stool	Mar., '23	25c
19.	Grandfather's Clock	Apr., '23	25c
20.	Flat Top Desk	Apr., '23	25c
21	Colonial Desk	Apr., '23	25c
22	Cabinet and Desk	Apr '23	25c
23	Pergola Garage	May, '23	25c
24	Gateleg Table	June, '23	25c
25.	Canoe Sailing Outfit	July '23	25c
26.	Baby's Crib and Pen	Sept., '23	25c
27	Kitchen Cabinet Table	Oct., '23	25c
28.	Pullman Play Table	Nov., '23	25c
29.	Toy Tea Cart etc.	Dec., '23	25c
30.	Tool Cabinet etc.	Jan., '24	25c
31	Sewing Cabinets	Feb., '24	25c
32.	Chinese Game Table	Mar., '24	25c
33.	Dining Alcove	Apr., '24	25c
34	Garden Trellises	May, '24	25c
35.	Simple Radio Cabinet	Oct., '24	25c
36.	Rush Bottom Chair	Nov., '24	25c
37	Simplified Bookcase	Dec., '24	25c
38.	Sheraton Table	Jan., '25	25c
39.	Sewing Chest	Feb., '25	25c
40.	Desk in Sheraton Style	May, '25	25c
41	One Tube Radio Set	May, '25	25c
42	Three Stage Amplifier	June, '25	25c
43	Four Tube Receiver	July '25	25c
44.	Pirate Ship Model—Hull	Feb., '26	25c
45	Pirate Ship—Details	Mar., '26	25c
46.	Galleon Model—Hull	May '26	25c
47	Galleon Model—Details	June, '26	25c
48.	Sailing Yacht Model	July, '26	25c
49.	Broom Cabinet	Aug., '26	25c
50	Airplane Model (Flying)	Sept., '26	25c
51	Clipper Ship Model—Hull	Oct., '26	25c
52.	Clipper Model—Details	Oct., '26	25c
53	Clipper Model—Rigging	Nov., '26	25c
54.	Five Tube Radio Set	Oct., '26	25c
55	Five Tube Set—Details	Oct., '26	25c
56.	Bird and Animal Toys	Dec '26	25c
57	Constitution Model—Hull	Jan., '27	25c
58.	Constitution—Rigging	Feb., '27	25c
59	Constitution—Rigging	Mar., '27	25c
60.	Welsh Dresser	Mar., 27	25c
61.	Viking Ship Model—Hull	Apr., 27	25c
62.	Viking Ship—Details	Apr 27	25c
63.	Toy Motor Boat—Hull	May, '27	25c
64	Toy Motor Boat—Details	May, '27	25c
65	Six Simple Block Puzzles	June, '27	25c
66.	Ship Model Weather Vane	Aug., '27	25c
67	Toy Model of Lindbergh's New York to Paris Plane	Aug., '27	25c
68.	Magazine Rack Table and Book Trough Table	Sept., '27	25c
69.	Flying Model Fit of Lindbergh's Monoplane	Oct., '27	25c
70.	Console Radio Cabinet	Nov., '27	25c
71.	Console Cabinet—Details	Nov., '27	25c
72.	Doll's House	Dec., '27	25c
73	Doll's House Furniture	Dec., '27	25c
74	Santa Maria Model—Hull	Dec., '27	25c
75	Santa Maria—Rigging	Dec., '27	25c
76.	Santa Maria—Details	Dec., '27	25c

Name
(Please print name and address very clearly.)

Street

City and State

LIONEL

For Boys who want to be men, and men who want to be boys

IF you could take a great railroad system that runs across the Continent and transform it into a miniature size for your home—you would have Lionel, the most realistic electric railroad in the world! It is 100% Electrically Controlled—it is so real—it operates as if by magic.

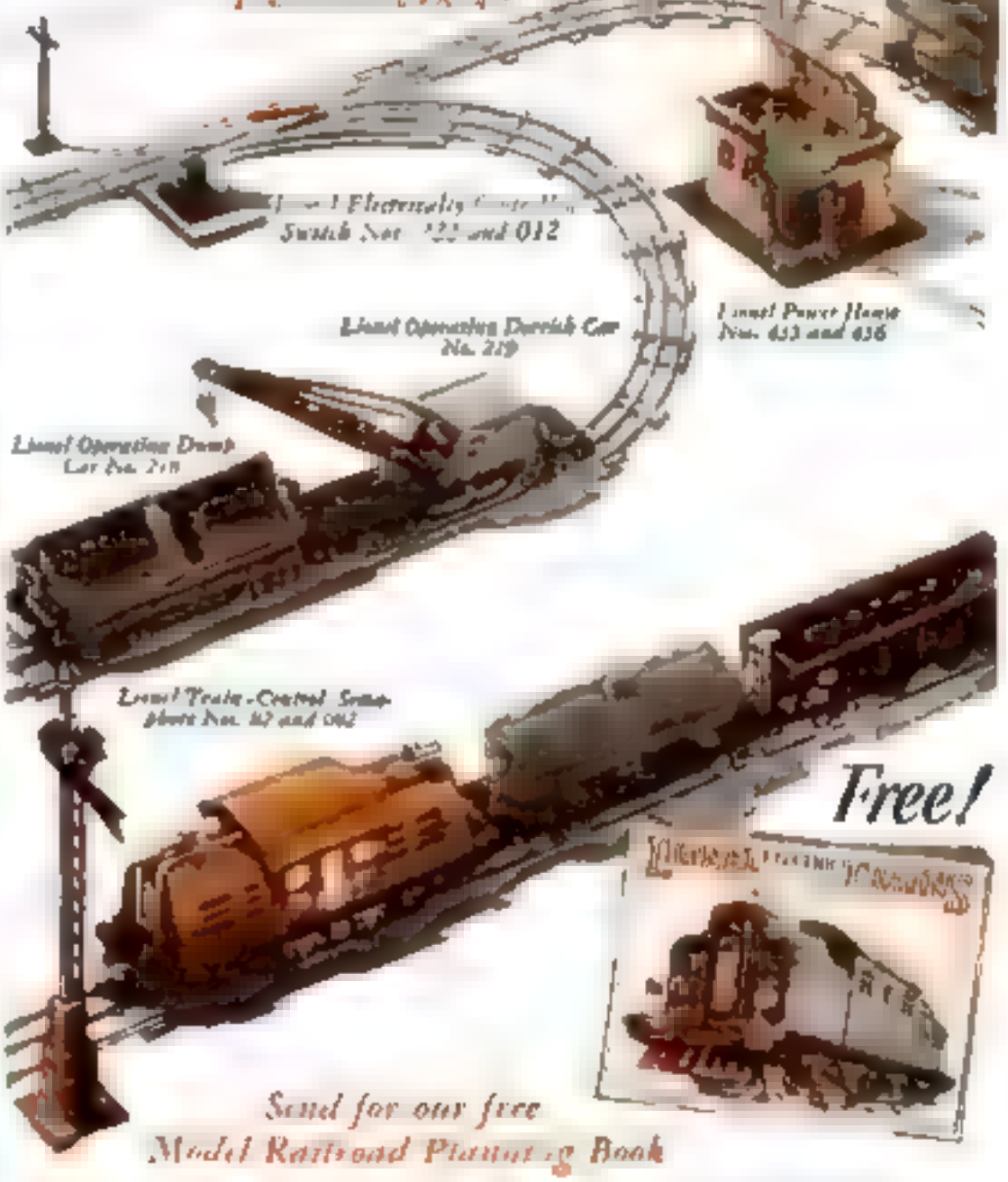
Imagine yourself on Christmas morning, the gleaming tracks all laid out—the wiring all hooked up, illuminated station in its place, lamp posts shining brightly, everything set. And there waiting to go is the beautiful Lionel Super-Motor Locomotive, ready to thunder down the rails with its Pullmans, Diner, or as many of the twenty-nine different Lionel Freight Cars as you choose.

Lionel All-Steel Tunnel No. 120L Illuminated

You're sitting at the switch tower, your hand at the controls. Touch a lever and presto!—the train comes to life, speeds up and whizzes away! Watch her as she passes the crossing gates, which automatically raise and lower—there she glides through the illuminated tunnel—then takes the turn and approaches that marvelous new Lionel Train Control Semaphore. The red light's on—arm is down—the train halts automatically—then as the arm raises and the green light flashes your train once more is on its way! Now there's a switch ahead—back in the switch tower you touch a lever and the track switch is thrown—and your train whisks into a siding! And remember, you can stop it and back it out onto the main road again by manipulating the levers in the switch tower. Always you can control your Lionel Train at any distance down the track.

Lionel Electric Bell-Signal Nos. 069 and 69

What fun! Play a thousand games—dream a thousand dreams with a Lionel Railroad. There are so many astounding features—the new Lionel Derrick Car for example, which has operating boom and tackle! Amazingly real. You have to see it operate to believe it!



Send for our free Model Railroad Planning Book

See for yourself just how wonderful the Lionel Railroad System really is! Our book is the most elaborate ever published. In full colors it shows the great variety of Lionel Trains and Equipment. It describes the Lionel 100% Electrically Controlled Railroads for "O" Gauge and "Lionel Standard" Track. This great 40-page book shows the supreme quality and built-in excellence of all Lionel Products. Sets from $5.75 to $300. Send for the book today.

See Lionel Products demonstrated at the leading department stores, toy, hardware, electrical, sporting goods and furniture stores

THE LIONEL CORPORATION, Dept. F, 15-19 EAST 26TH ST., NEW YORK, N.Y.

"STANDARD OF THE WORLD SINCE 1900"

LIONEL ELECTRIC TRAINS

MODEL RAILROAD ACCESSORIES

"MULTIVOLT" TRANSFORMERS

A Doll's House

(Continued from page 73)

board (No. 5) serves both as floor and ceiling. It is sandpapered on both sides.

The rooms will be so small when the house is assembled that it will be next to impossible to do much nailing or other work within them. For this reason it will be best to do all the fitting of doors, bases, casings, stairs and the like before the house is completed. The three sections shown in Fig. 3 should each be assembled as separate units. Do all wall painting

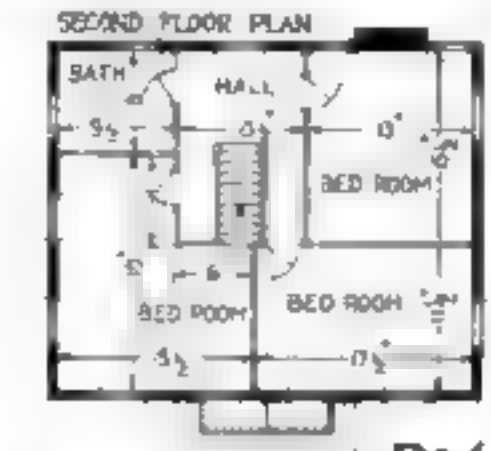
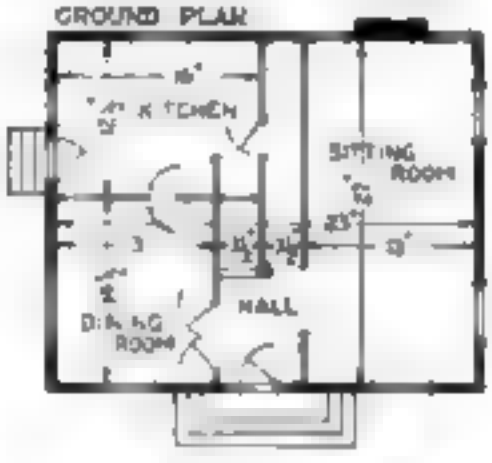
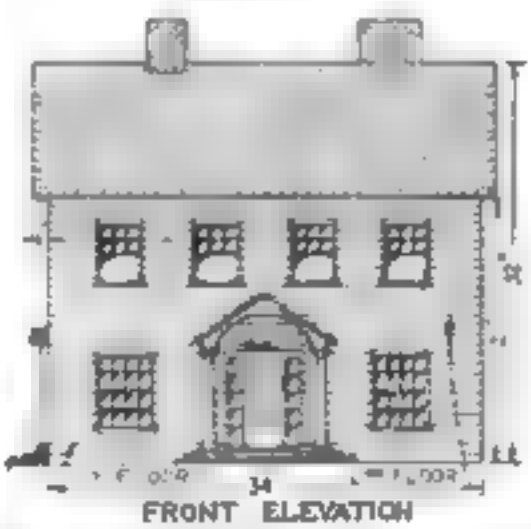


Fig. 1





How closely the model resembles a real house is shown by the plans and front view

or decorating and floor polishing while the sections are still open.

Next, the outside walls should be made up. The door and window openings should be marked out accurately on both sides of the board and cut out with an ordinary coping saw or keyhole saw.

For casing and finishing the doors and windows see Figs. 5 and 6. The casings may be made of ¼-in. wood. The cheap varlstocks that some firms use as advertising mediums, if planed smooth and ripped through the center, are just the thing for this purpose. If these cannot be found, heavy cardboard or berry crates will serve quite well. If the casings are

(Continued on page 106)


for Xmas
GIVE HIM THIS
Craftsman's Wonder Home Work Shop
$10.00 DOWN
What finer Gift could a family make to Husband, Father or Son?
Waco Craftsman's Lathe
The Complete Equipment consists of the powerful Red Jacket
The Famous Waco Red Jacket Guarantee
If our tools are not what you want when you see them, send them back.
Look Out For Imitations:
Special Crafts Course
Buy On Your Own Terms Only $10.00 down. Liberal discounts for cash.
Interesting Literature Free
10 DAYS' FREE TRIAL
Our literature tells you how to start a job of your own. If you are not pleased return the Shop.
free CRAFTS COURSE
free BLUE PRINTS
MAIL THIS TO WACO
WACO TOOL WORKS, Inc.
542-4 N. Parkside Ave., Chicago, Ill.
10-day free trial, free blueprints, and $10 down payment.
Name
Address

A Doll's House

(Continued from page 104)

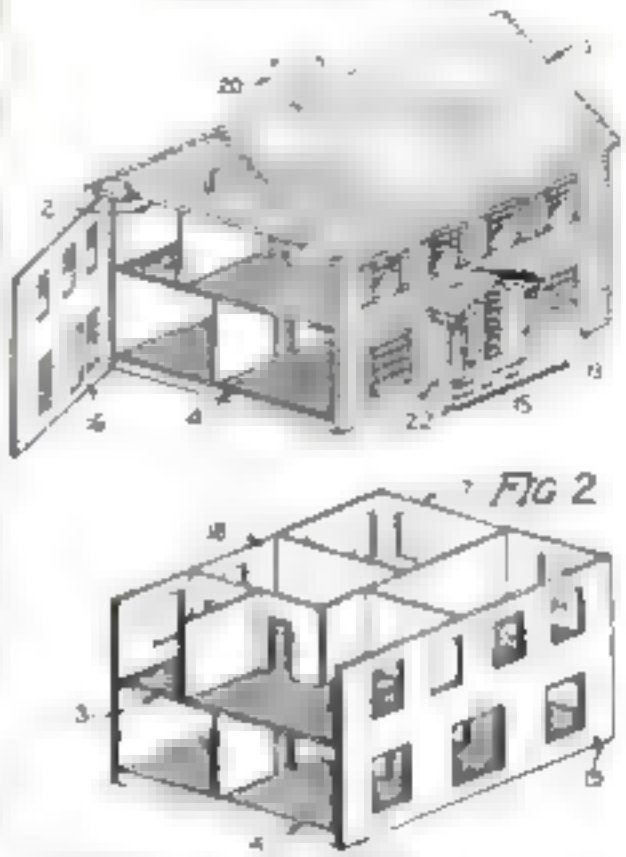


FIG 2

The floors, walls and partitions before and after the roof and trimmings are added

placed even with the edge of the openings. frames will not be needed. The base boards should be ¼ in. wide and the same thickness as the casings

The stairs will be found to be the most difficult part of the construction. It is hardly possible to show their construction fully enough, but the details can be supplemented by the reader's observation and ingenuity. The construction of the stairs is indicated in Fig 4. The stair steps may be glued to a thin board, each step being a solid block. Another plan would be to cut the steps from a solid block. Only the six lower steps are exposed to view, the other seven being hidden between walls Nos. 12 and 14. The stair well in the second floor is 3 by 7¼ in. and cut so that it is directly between walls 12 and 14

The balustrades are made of match sticks glued between a top and bottom rail. The newel post may be a clothespin or a round penholder.

When all of the (Continued on page 108)

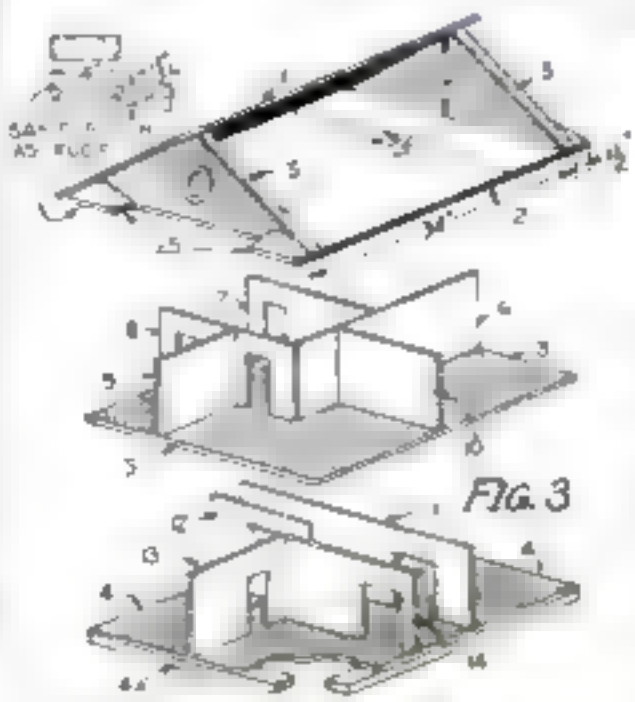


FIG. 3

The house is made in three parts the small fittings are added before putting together

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

A Doll's House

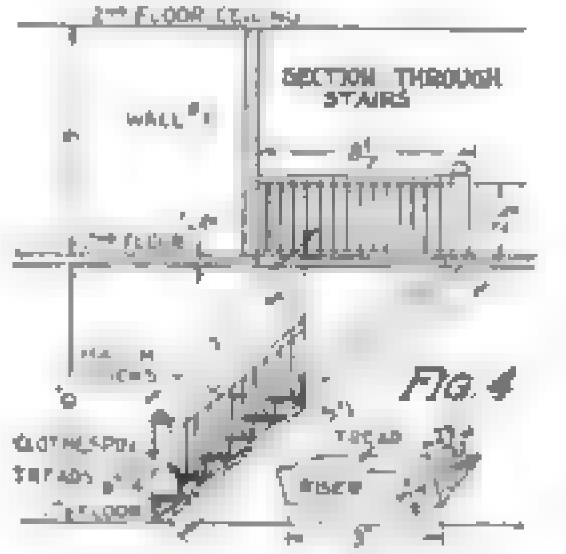
(Continued from page 106)

small details are in place and the walls tinted, the three sections shown in Fig. 3 may be assembled, using ½-in. flat-head screws. The front and back should be screwed in place at this time and the two ends and roof hinged. One hinge on the roof will have to have an extension soldered to it to allow it to open out to the line of the chimney.

It is left to the reader as to what kind of roof he will use. Small shingles may be nailed or glued in place; they look well but take a great deal of time to construct. The divisions between the shingles may be represented by making grooves with the point of a nail set or a chisel. The same method may be used for lining the siding boards.

The chimneys are made of solid blocks of wood and the bricks carved with a chisel or sharp knife.

The construction of the front entrance



The stairs are made by gluing triangular steps to a thin board and adding tiny treads

is shown in Fig. 1 and more in detail on Blueprint No. 74. The arch is shaped with the coping saw; the roof boards are made to match the main roof. The columns may be turned on a lathe or made square, or a small bracket may be used to support the sides of the roof.

The steps in front and at the side are merely three ½-in. sections fastened together and carved like the chimneys. The sunburst design over the door may be carved with a knife or carving chisel.

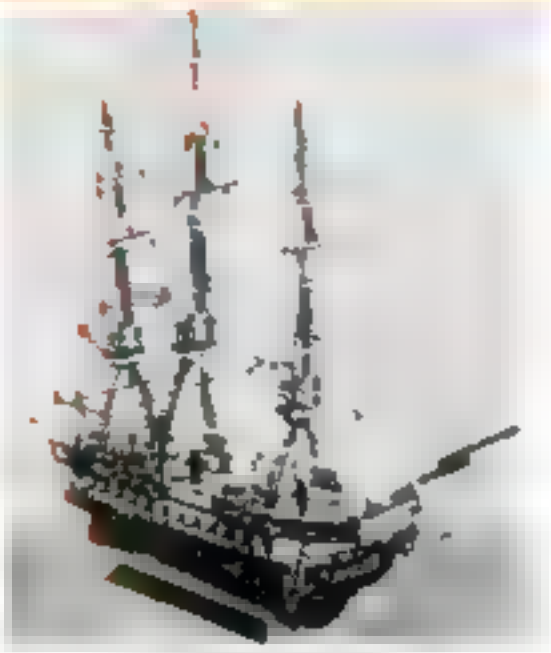
Making up the window sash is more tedious than difficult. A good sharp knife will be the greatest asset. The method is shown in Fig. 6. Tough and quite heavy cardboard should be used. When the sash are cut they are glued to a piece of glass or celluloid of the same width and length. Each sash should be made to fit its particular opening. The construction of the doors also is shown in Fig. 5.

Small green shutters serve to brighten the appearance of the house and may be made easily. A piece of very thin wood with a simple design grooved in the outside face is all that is needed for each shutter. These pieces are nailed to the side of the windows.

Small window boxes—blocks with holes for the flowers—may be used under the windows. Pieces of sponges, colored like plants and (Continued on page 111)

GETTING AHEAD?
Read the advertisements on Pages 146 to 174 this issue if you want to get ahead.

BUILD YOUR OWN SHIP MODEL



CONSTITUTION
Size 30" high, 12" long, 10" wide overall

You can build a beautiful Ship Model as low as $4.98 or a Loudspeaker Ship Model for $12.50 with your own hands in a few hours of pleasant pastime from parts, cut to fit and ready to assemble, supplied by the largest builders of ship models in the world.

A fifteen-year-old school boy won first prize in a model building contest with a Constitution model built from our kit of parts. More than 1000 models were entered in this contest.

LA PINTA
A Ship Model Loudspeaker
Size 28" high, 27" long, 12" wide overall

We will supply the parts for the Constitution (Old Ironsides) cut to fit and ready to assemble for $6.98. This price includes every part necessary for constructing the complete model. Full instructions for assembling Old Ironsides are included with each kit. A diagram of parts, showing the number of the parts and just exactly how to piece together the model, make it impossible for you to make a mistake. Other beautiful ship models can be built from our cut to fit and ready to assemble parts. We have kits for the Santa Maria, the La Pinta and the Mayflower at $4.98 each.

This is the most beautiful loudspeaker on the market. We will supply you with all parts necessary and complete instructions for building this beautiful loudspeaker ship model. The price of $12.50 also includes the melody mill and loudspeaker unit. The unit is of the Electro Magnet type and does not require power amplification to bring out the low notes as it gives faithful reproduction at all frequencies. The movement is deeply imbedded in the solid wood hull and the unit is attached to the mast, making it impossible for counter-vibrations to effect reproduction.

A USEFUL AND ORNAMENTAL HOME DECORATION

No doubt you have often admired ship models and yearned to possess one but could not do so because the price was too high. Let the WORLD'S LARGEST BUILDERS OF SHIP MODELS AND SHIP MODEL LOUDSPEAKERS supply you with all the necessary parts, cut to fit and ready to assemble from which you can build a beautiful model.

You need not know anything about ship building or carpenter work in order to build one of these ships. No special knowledge of ship model building is necessary either. We will supply all the parts, from the hull down to the smallest piece, all cut to fit and ready to assemble. You cannot go wrong. Diagrams and plans of parts that are included with each kit tell exactly what to do with each part.

These plans show you step by step just how the model is constructed. Everything is made so simple that even a small child can build a beautiful model.

All you need is a small hammer to tap the parts into place. Here is a part of the instructions copied word for word from the diagram and instruction sheet that goes with the kits: "Take part No. 57 place it in front end of part No. 56 and tap lightly with a hammer. Next take part No. 58 and place it up against No. 57 and tap it with a hammer to bring it into place."

Easy! Nothing simpler. The instructions are like that from beginning to end. Do this and that and before you realize it a beautiful ship model has grown before your eyes.

Write for our free, beautifully illustrated catalog, which contains photographs of all our models together with complete details and price of each. We will send this catalog without obligation to you. Fill in the coupon below and we will act upon it immediately.

If, after assembling the model according to our instructions, you do not think it worth many times the purchase price, return it to us in good condition and we will gladly refund your money.

MINIATURE SHIP MODELS, Inc.
3818-20-22-24 Baring St., Philadelphia, Pa.
Canadian Branch: 1485 Bleury St., Montreal, Canada
Canadian Prices Slightly Higher. Send all Canadian Orders to Canadian Office.

MINIATURE SHIP MODELS Inc. DEPT O-3.
3818-20-22-24 Baring St., Phila., Pa.

Please send me complete parts, cut to fit and ready to assemble for the Constitution, $6.98 ☐ Santa Maria, $4.98 ☐ La Pinta, $4.98 ☐ Mayflower, $4.98 ☐ Melody Ships: La Pinta, $12.50 ☐ Santa Maria, $12.50 ☐ Mayflower, $12.50 ☐ I will pay postman purchase price plus postage (a few cents).
Check which model you want shipped.

PLEASE PRINT NAME AND ADDRESS PLAINLY

Name .....
Street or R. F. D. .....
City .....
State .....

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

A Doll's House

(Continued from page 116)

strips and glued on top of the boxes, are quite effective.

Careful painting adds greatly to the attractiveness of the house, it is one of the most important items. The colors suggested are green for the roof and shutters, white for all of the body and doors and window sash and red for the steps and chimneys. It is well to give the house two or three coats of paint or enamel or lacquer.

The inside woodwork should be painted

A simple way to make the sash and doors. The latter vary in size, as shown on Blueprint No. 73

FIG. 5

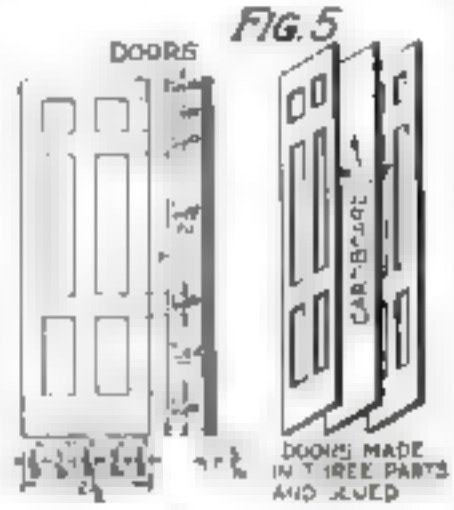
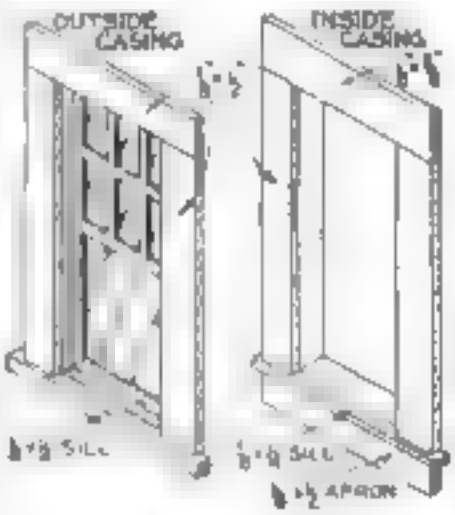


FIG 6



How the outside and inside casings are placed around the window openings

white along with the doors. The floors may be stained or finished with clear varnish. Paper or tint the walls.

Furniture, bath and kitchen fixtures may be obtained ready made at the toy shops, where some substantial and well formed models are to be found. These should be of the proper size to match the house. It is more satisfactory, however, to make the pieces in the home shop. Full size designs for tables, chairs, a couch, a hall clock, a bed and other furnishings are given in Blueprint No. 73.

The porcelain fixtures for the bathroom and kitchen may be shaped or carved from solid wood to resemble as closely as possible the real pieces. These models are covered with a heavy layer of gesso made of glue and whiting and painted with white enamel to resemble porcelain.

Filter for Purifying Cistern Water

By M. G. Kains

IN MANY places it is advisable or desirable to use water from cisterns rather than from wells; for instance, where the water is alkaline or brackish, or if there is doubt as to its purity

When the owner does not feel justified in going to the expense of building a filter cistern, the method described below will serve the purpose. The apparatus is nothing more than a filter placed above ground, preferably on top of the cistern.

A properly constructed cistern is supposed to be already installed and well lined with cement. Also, the usual provisions for cleaning it should have been made, even though cleaning will rarely have to be done.

In the center of the bottom of a strong, water tight barrel or large cask, bore a hole large enough to accommodate a 3-in. vitrified drain tile, which must be fitted snugly in place and cemented all around to prevent leakage. Beside it, on the bottom of the barrel, place two bricks. Cement or otherwise fasten them to the bottom to prevent their shifting.

Sectional view of a filter for a cistern

Plug with cement the small end of another vitrified tile of a size large enough to slip over the 3-in. tile. This is to prevent water from leaking through at that end. After the cement has set, invert this tile over the small one, the top of which will be about 2 in. below the plugged end of the large tile because of the bricks upon which it rests. The bell end of the large tile is the one that rests upon the bricks.

The barrel must be placed so that the tile in its bottom passes through a hole in the top of the cistern, or so that it connects with a pipe to conduct the filtered water into the cistern. Then the barrel is two thirds filled with sand and powdered charcoal in alternate layers each of about 4 in.

A float nearly as large around as the barrel head is placed upon the top layer of sand. This is to spread the water as it pours in from the eaves leader and prevent the sand from being stirred up unduly. A cover upon the top of the barrel will keep out dirt that might come from other sources than the roof. The apparatus is now complete.

The upper layer of sand, which should be at least 6 in. thick, will catch all dirt from the roof. Therefore, it should be cleaned at intervals and occasionally replaced with fresh sand. Once or twice a year it will be well to replace all the sand and charcoal with fresh layers.

How to Drive Your Tool Grinder by Foot Power

A CHANGE in our home electrical system deprived me of a motor-driven tool grinder. I fell back on a hand-turned grinder and worried along with it for quite a while. This often meant enlisting family assistance, with few volunteers. A bright thought: why not foot power? The foot device could be bought, but perhaps it could be made just as well out of odds and ends.

First, the crank of the grinder was shortened a couple of inches with a hack saw, leaving the first bolt hole to which

Grinding tools in the home workshop be comes much less of a task if a pedal attachment is made for turning the hand grinder

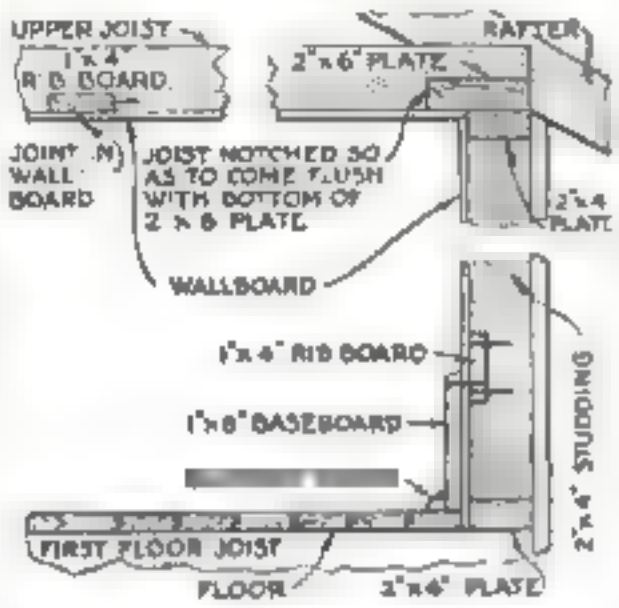
the turning handle had been attached.

For the long connecting rod from grinder to pedal, I selected an old hockey stick, cutting it off 2 ft. 6 in. long. A hole was drilled through one end for a bolt to attach it to the grinder crank. At the other end the stick was T-hinged to a board pedal and the latter in turn was supplied with a larger T hinge to be fastened to the concrete floor.

The first model done off and and in a hurry, was a sad failure. The dejected inventor suspected that he had violated some unknown but vital principle laid down by Archimedes. He scratched his head and surmised that perhaps the pedal was too short. So he substituted a longer board—one 4 in. wide and 2 ft. long. It worked. All that remained was to anchor the larger hinge to the floor with bolts held with melted lead in drilled holes. Instead of lead, ordinary cement or 24-hour-hardening cement could have been used.—J. R. McM

A Workmanlike Way to Apply Wallboard

WHEN building a house which is to be lined with wallboard instead of the regulation lath and plaster, time will be saved and a better job will result if the builder takes the forethought to cut notches in the studding and joists of a size to receive a 1 by 4 in. rib board, as shown. The rib on the 2 by 4 in. studs should be located so as to come a little above the baseboard, and the ones on the



How the ribs and plates are arranged to insure adequate bearing and nailing surfaces

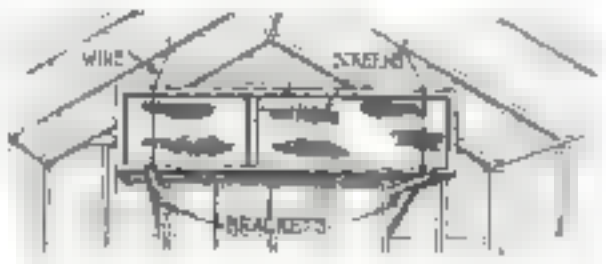
ceiling joist wherever the joints in the wallboard will come.

Instead of the usual 2 by 4 in. double plate, use a 2 by 6 in. plank for the upper member. This gives a nailing space of 2 in. all around for the wallboard. The ceiling joists are sized at the ends so as to come flush with the under face of the 2 by 6 in. plate.

This method will be found to be a great improvement over the usual way of "cobbling" in scrap pieces here and there to get bearing and nailing surfaces for the edges of the wallboard sheets.—GEORGE W. ROYER.

Storing Screens in a Garage

FOR storing screens I use the single 2 by 4 in. beam across the center of the garage just under the pitched roof. Three cross members are nailed on top of the beam so that they support the top, bottom and center members of a screen door.



The porch screens are placed on brackets extending from the end wall of the garage

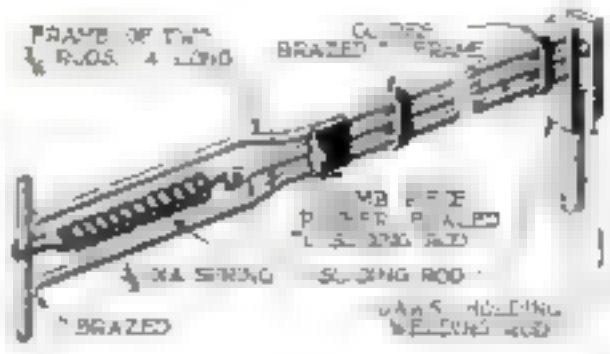
On top of the door I pile all the wooden screens.

When I inclosed the front porch with portable screen panels, there was not sufficient room on the top of the single cross beam to store them, but I put up two braces as illustrated on the end wall of the garage.—J. F. HARDECKER.

Quick-Acting Holder for Short Welding Rods

WELDING rods seem to be regarded cheaply by some welders, but in a month's time a considerable amount of money will be represented by the pile of short ends accumulated in a busy shop.

One way of using up the short ends is to fuse the pieces together, usually as the work goes on, by welding the short rod to



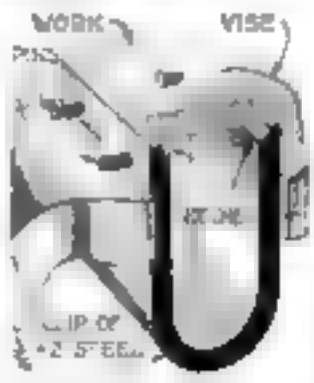
How to make a holder which allows short bits of welding rods to be handled safely

the end of the succeeding one. However economical this may seem, it costs something to gas and time to stick the rods together, so the saving may be more imaginary than real.

A sure way to save the rods, without expense, is to use a rod holder such as is illustrated. The one shown can be made in a few minutes spare time, and is used to hold the welding rod when it gets too short to be safely held in the fingers.—WILLIAM J. REESE.

Clip for Vise Expedites Filing of Thin Work

SMALL die parts, or other thin pieces similar to that shown in the illustration, are very difficult to hold in a vise without marring the edges, if they can be held at all. In addition, there is the danger that the file will be damaged by the contact with the hard jaws of the vise.



Holder for thin work which is to be filed

A strip of thin soft steel, provided with notches to receive the work and bent as illustrated, will solve these difficulties. If desired, pins can be added to hold the clip at the proper height.

Clamp Puller for Shafts

A puller of simple design for extracting stubborn shafts

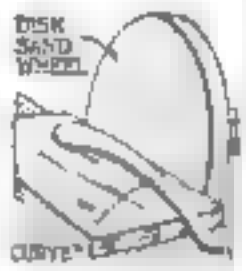
THIS extractor was made for removing shafts from holes, withdrawing dowels that cannot be driven out, and similar work. It looks like the conventional clamp dog, except that it has two set screws.—G. A. L.

Getting Ahead?

Read the advertisements on Pages 148 to 174 this issue if you want to get ahead!

Making French Curves for Drafting Use

THE problem of supplying draftsmen with sufficient irregular curves (French ship or railroad) has always been a rather hard one to solve. If the company buys them, they are continually getting lost or misplaced, if as is generally the case, the individual draftsman is left to provide them, some men neglect to do so and are continually trying to borrow them.



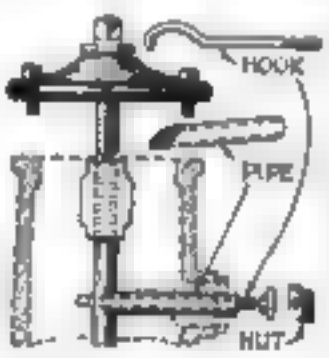
The curves are molded smooth

One concern solved this difficulty by purchasing ¼-in. sheet celluloid, which is supplied to the men with permission to use the shop facilities in their own time to make their own curves. As the shops work one hour later than the drafting force, this was easy to arrange.

The accepted method of making the curves is to lay an existing curve on the celluloid sheet, scribe its outlines, tack the sheet to a thin piece of wood and cut it on a fine band saw, leaving sufficient margin for trimming. It is then removed from the wood and carefully finished by freely swinging it back and forth across a sanding wheel.—J. F. HARDECKER.

Hooklike Tool for Repairing Fire Hydrants Quickly

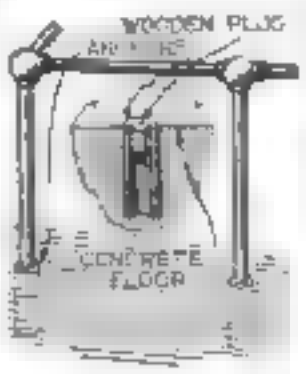
IN REPAIRING anything about the top part of fire hydrants, C. H. Dale, Superintendent of the City Water Works of Galena, Kansas, saves time by using the simple tool illustrated. It is obvious that a similar device could be used for other purposes where a pipe or shaft has to be kept from turning in an inaccessible place or some position which will not allow an ordinary pipe, chain or strap wrench to be used to advantage.



A strong clamp for use in awkward places

Sockets Placed in Concrete Floor to Save Drilling

WHEN supervising the laying of a concrete floor in a building which was to house electric transformers, the foreman ordered the placing of a number of 1-ft. lengths of 1¼-in. iron pipe vertically in the concrete. These were made in addition to the usual supports for the machinery. They shortly proved useful and justified his foresight when additional guard rails had to be erected.



Using short lengths of pipe as sockets

Holes are so frequently required in shop floors that it often would pay to place short pipes at 5- to 8-ft. intervals.

Lathe Used in Emergency to Cut Long Keyway

By George A. Volz

IT HAS been said that the engine lathe is the foundation of machine shop practice and that any other machine tool could be dispensed with much more easily than it. Examples of its versatility are often found. Lathes are used for milling operations, for facing that is really planer work, and, in the set-up illustrated for keywaying a long arbor for a milling machine.

This arbor was made for some special work. It was complete with the exception of the keyseat when I found there was no milling machine, shaper or planer available in which to do the keyweying, so I proceeded to do the job in the lathe.

A starting hole was drilled next the collar on the arbor which was then placed

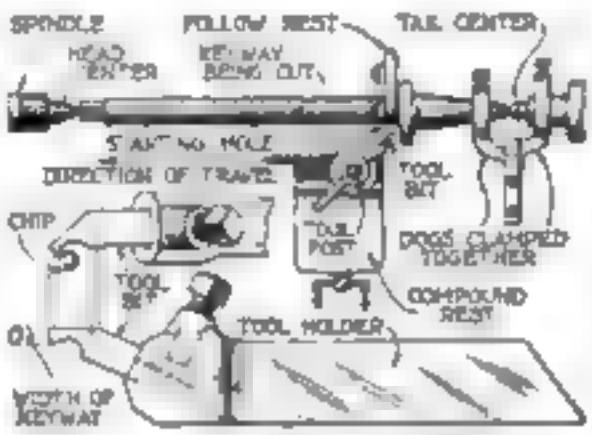


Diagram showing set-up and tool bit used for keywaying a long arbor in a lathe

between the lathe centers. The follow-rest was set up to the arbor. A tool bit was ground as shown and set precisely on the center of the lathe and at a negative angle to avoid digging and chattering. It was placed diametrically opposite the rear jaw of the follow-rest.

One lathe dog was placed on the arbor shank and another on the tailstock spindle. The arbor was turned until the tool would enter the starting hole. The two dogs, after being brought into contact with each other were tightened and clamped together to hold the arbor so that it could not turn out of line.

The lathe was geared to cut a coarse thread and run in back gears. The live center was well oiled to lessen the tendency of the arbor to revolve.

The tool was fed in to take a light cut, the lead screw nut thrown in, and the carriage run the length of the arbor. The tool was withdrawn, the nut disengaged, and the carriage returned to take another cut just as would be done in chasing a thread. It did not take many cuts or much time to finish the keyway cut.

Ordinarily, of course, the cut would have been taken toward the tailstock, but the collar on the arbor prevented that.

When grinding taper shanks on arbors for milling machines, end mills, or any tool having a taper shank, more satisfactory results will be obtained, especially in the case of old machines, by relieving one third of the length of shank ½ in. under size. This causes the bearings to be on the ends.—H.J.C.

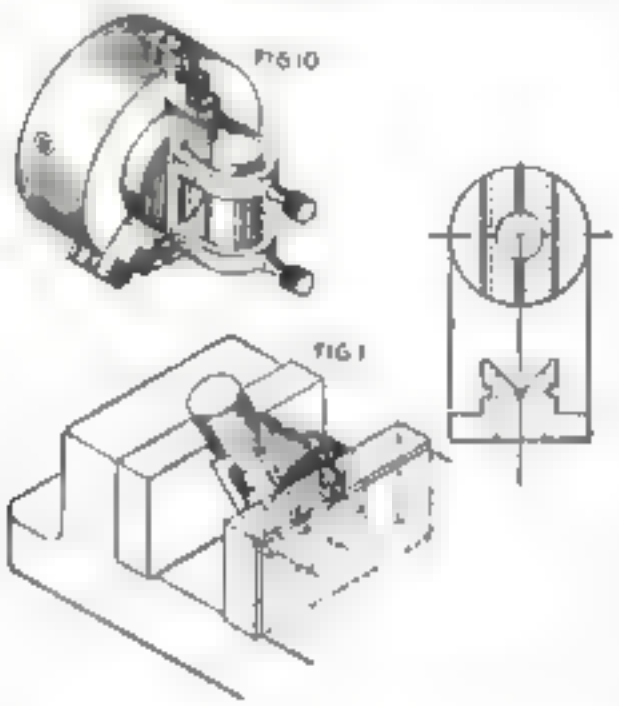
Using the Vee

(Continued from page 76)

which locks the work firmly in a three-point contact ready for drilling. The head of the spreader pin prevents the drill from striking the ends of the hardened vees, while permitting the maximum support for the work

Off-center drilling can be done by the same method, merely by inserting a size

This fixture helps in boring round stock and can be pivoted as illustrated for milling cuts



block or shim of one half the desired offset behind the vees and another in front of the drill block, as in the diagram of Fig. 8.

A variation of the regular vee-block which can be made in a very short time and which is useful for very small work is shown in Fig. 4. The set of blocks illustrated has a series of grooves, each corresponding to successive variations in the diameter of the work of ¼ in. Non-shrinking tool steel should be used for these blocks, a pair of which are made in a single piece enough longer than the finished set to allow for finishing the ends. Before milling, the piece is first ground square on all four sides. Next the grooves are milled. The block is then cut in two, the ends finished and the pieces hardened. Blocks of this kind are often useful in holding small parts of varying diameter, as indicated in the illustration. They can also be used for squaring the ends of soft wire or small rods in a vise, as shown in Fig. 5.

In forming the grooves, it should be noted that in order to get a certain difference in diameter of the parts held in them, it is necessary to vary the depth by 1.414 times the difference in radius, or .707 times the difference in diameter, as will be seen from Fig. 3. To get a variation of ¼ in. therefore we must drop the miller table a distance of .0156 in. times 1.414 or .022 in.

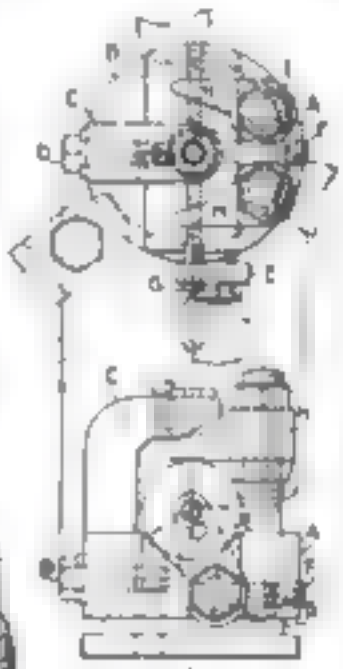
Another type of vee device which is designed to use standard parts is the one in Fig. 7. This small center drill jig is complete within itself, with vees and bushings interchangeable. As will be seen, it is largely completed on the lathe, the only additional work required being the formation of (Continued on page 118)

Using the Vee

(Continued from page 117)

the two milled openings, and a threaded hole for the holding screw. The vee is in the shape of a cylindrical piece snugly fitting the bore and seating against a shoulder in the end of the latter. Standard drill-bushings of the same diameter as the hole in the vee-block are used to guide the drill and are held against the work by the regular hooting screw which also clamps the work. The broad foot provides a ready bed for mounting the jig on the drill table. With the jig hardened and the bore ground, this little device makes a very accurate and durable article, which will pay for itself many times over.

A larger centering device designed to be used for drilling and boring in the chuck or on the faceplate of a lathe is that shown in Fig. 10. It is made from a cylindrical piece with the profile of a standard vee-block milled out in order to allow the use of regular vee-block clamps. A hole slightly larger than the largest diameter it is expected to bore is formed concentric with the outer surface, and the vee-groove is placed exactly diametral to these surfaces. Because of its shape, this holder can either be held in a lathe chuck or lined up on the faceplate, the ears left by the milling giving ample footing for the clamps. It will take careful work to get the vee centered on the holder and true in every way, but the time and care expended in getting



Here is a universal tool that performs many functions in drilling, milling or boring plain or shouldered round work. Note the holding fingers – firm but out of the way of the cutter

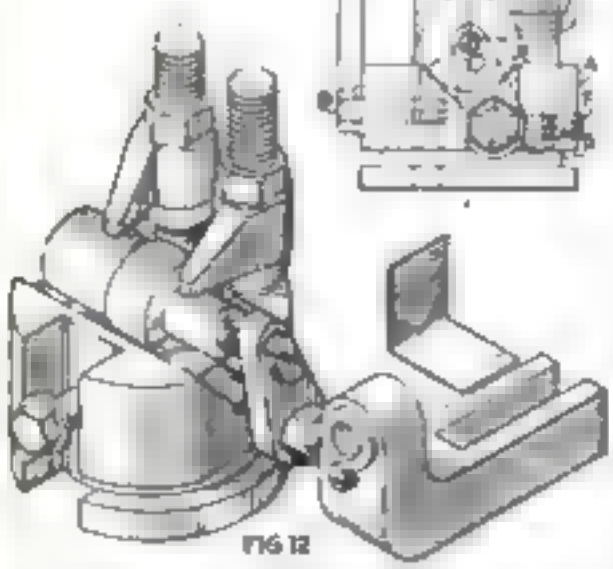


FIG 12

this right will be found to pay well, as the work is automatically aligned whenever the jig is placed on a three-jawed chuck, or indicated from the center hole.

As in the case of other vee devices, work of two diameters can be supported by the use of blocks placed under the smaller diameter and against the sides of the groove. With the vee of Fig. 10 held in the

(Continued on page 119)

Using the Vee

(Continued from page 118)

three-jaw chuck, off-center boring to a predetermined amount can also be done by a variation of the same method. In the case of a difference in diameters only, the thickness of the blocking used will, of course, be equal to that of the difference in the radii of the work. In boring off-center, however, the thickness of the blocking will have to be 1.414 times that of the desired off-center distance. Parts which must be supported on two different diameters and offset at the same time will require two raising blocks under the smaller diameter, and a block on one side of each diameter equal to 1.414 times the offset, as shown in Fig. 9.

THE usefulness of this particular jig does not end with its application to the faceplate of the lathe or the table of a drill. Fig. 11 shows it used in connection with a miller vise on a job requiring the formation of a slot or surface in angular relation to the axis of a cylindrical piece. Anyone who has ever tried to do this with ordinary equipment will understand the difficulties of such a job, when a number of duplicate pieces must be handled. The holder is pivoted in a special jaw in the miller vise. In the February 1927 number of POPULAR SCIENCE MONTHLY the writer described such a jaw for holding various centering devices. Where a jaw of this kind is on hand, it can be readily used in the set-up illustrated. Otherwise one will have to be made, but even this will not be a great deal of trouble. The pin should be a light driving fit in the vee-holder and a turning fit in the jaw, where it can be locked by tightening the set screw. The inclination of the work can be determined by the use of a protractor, which, once set, will remain undisturbed for duplicate pieces.

Rapid manipulation, as well as positive location and a powerful three-sided grip on the work are advantages of this manner of locating. The rounded shape of the jig also permits maximum space for the cutter, no projections being in the way as in the case of a square block, which would be difficult to maintain at the desired angle. If intended to be used regularly for this kind of work, the bottom face of the holder may be made with graduations and the miller jaw with a corresponding central mark, so that the holder can be set without the use of a protractor.

THE devices so far described have been of the simplest nature, and while they are highly useful and have a comparatively wide range, they cannot be termed universal. In Fig. 12 is shown a vee fixture to which this appellation may rightly be applied. This versatile and yet simple device may be held in the lathe chuck or on the faceplate for boring larger holes. By removing the two upright posts, it may be used in the miller vise as described in the preceding paragraph. It is fully equipped for jig drilling, both center and off center, and to predetermined lengths. (Continued on page 120)

Using the Vee

(Continued from page 119)

and it is particularly adapted for handling work of several different diameters, both in connection with the drill-jig feature and for boring.

The jig consists of the main body A, made from a length of heavy round stock, the outer surface, bore and vee-groove being related to each other as in the last described holder. A deep groove B, near the bottom of the shape, serves as a footing for the clamps used in holding the jig to face plate or drill table, but the generally cylindrical shape also allows it to be held in either a three-jaw or a four-jaw independent chuck. To one side of the vee a deep slot is milled lengthwise of the body to form a seat for the drill-bushing arm C, which is clamped in position by a single cap screw D fitted with a pressed-on washer. From the construction of the bushing holder, it will be seen that the latter can almost instantly be removed or placed in position, adjusted for height, and clamped. This is important when using the jig for boring, as well as in arranging the work for drilling from the jig later on.

THE same construction renders particularly easy off-center drilling by predetermined exact amounts. All that is necessary is to place a shim of a thickness equal to the required off-set between the shank of the bushing holder and the bottom of its groove. For the drilling or boring of duplicate pieces to a uniform longitudinal location, a length gage E is provided. This gage can be swung in a semicircle, pulled out, and locked in any position by a clamp screw and brass plug F. Two holes are provided for the registering screw G to allow for work of varying height and diameter.

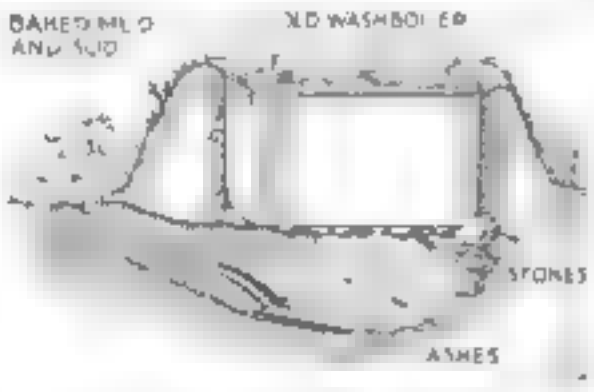
A feature of the greatest importance are the two work-holding fingers H. By reason of their shape and position, they combine the advantages of being always at hand and never in the way. Slidably mounted on the two heavy threaded posts I, they can be quickly adjusted to any angular position and any diameter within the range of the jig, and when tightened down, hold the work in a firm grip. The shape of these fingers is such that they leave a maximum unobstructed space around the point where the cutting tool is to work. Even when pushed closely together, they allow the bushing arm to be adjusted to within a short distance of the work, and with their points separated an inch or so, the bushing can be brought right down on to the part to be drilled, an important advantage.

NOVEL features are the insert vees, of which two are in use on the part shown in the illustration. These inserts are not difficult to make and it will pay to have a few of them on hand. For small differences in diameter, such vees can be made in a few minutes by bending a piece of sheet metal of the required thickness at right angles, as shown in the illustration. Hardened blocks should be used in doing this and care must be taken to get the surfaces perfectly flat and at right angles to each other.

The Shipshape Home

Back Yard Incinerator

INCINERATORS manufactured from heavy wire, concrete or sheet metal are often unsightly, and wire basket burners in particular permit small rubbish to fall through and litter up the ground. Without expense one can make a baked



Cutaway view of an outdoor incinerator which is both efficient and inconspicuous

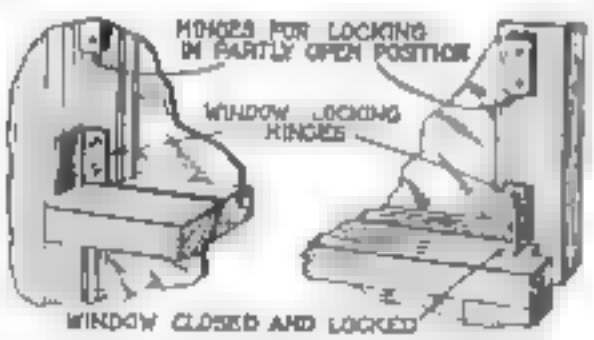
mud affair that is as efficient, yet is not offensive to the eye.

An old washboiler with the bottom knocked out supplies the form and lining. Build mud up around this gradually, letting each trowel full become firm before adding to it. Then put on strips of sod and keep them sprinkled until the roots take hold on the mud base.

In California this type of incinerator survives the heaviest rains. The good draft provided burns up all debris and the ashes can be removed and used for fertilizing lawn and gardens.—H. STANLEY.

Locking Windows

CHEAP, strong window-sash locks may be made as shown from small brass hinges, preferably nickel plated. Screw one on each side of the inside face of the upper sash with the bottom of the hinge in line with the top of the bottom sash and the hinge joint close to the parting strip in the window frame. To lock



Hinges used as locks to hold a window either partly open for ventilation or closed

the window, open the hinges. When the hinges are shut there is generally room enough to let the sash pass each other, but if not, countersink the hinges.

Should you want to lower the top sash or raise the bottom one to let in air and still have them locked, put on two more hinges, say 3 in. higher.—T. JEFFRIES.

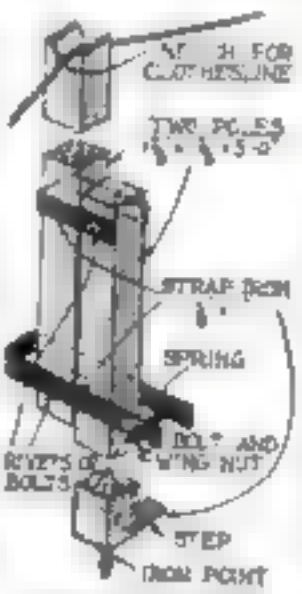
WHEN a hack saw breaks near one end and another blade cannot be obtained immediately, heat the broken end to draw the temper, drill a hole in it, and replace in the frame.

The Shipshape Home

Prop for Clothesline

THREE years ago I devised the clothesline prop illustrated and since then have made about twenty-five for my neighbors, who find them convenient because they can be placed directly under the line and extended to any height up to 10 ft. They cannot be blown down or knocked over

The materials needed are two pieces of wooden baluster stock 1¼ in. square and 5 ft long; 1 piece of strap iron, preferably galvanized, ⅛ by 1 by 2⅓ in., one ⅜-in. bolt 2½ in. long with a wing nut and another ⅜-in. bolt 4 in. long, a coil spring 2½ in. long, of a diameter to fit over a ⅜-in. bolt, six ⅜-in. bolts 2 in. long or rivets.



Adjustable clothesline prop with clamps

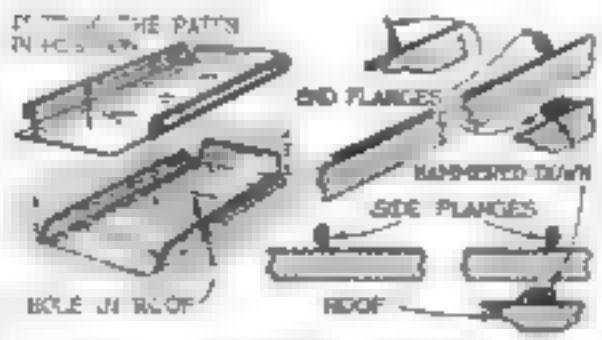
Cut the strap iron into three pieces, 11⅔, 10, and 4 in. long respectively Drill, bend and assemble them as shown. Cut or grind off the head of the 4-in. bolt to make a point for the prop. Note that the closed end of the larger of the two clamps or straps is allowed to project ⅜ in. beyond the wood as a hand grip.

To use the prop, stand it under the clothesline in a vertical position, take hold of it with the left hand at the upper clamp, place one foot on the foot rest, and pull up the lower clamp with the right hand Then screw the wing nut tight

JOHN BELL

Patching Metal Roofs

WHERE a section of a slanting metal roof has been eaten through by corrosion and the remainder of the surface is in such good condition that it does not need to be renewed the damage may be repaired by applying a patch as illustrated



A workmanlike method of applying a patch to a metal roof without soldering the seams

After the corroded metal has been removed, three edges are turned up as shown and a patch made and bent to fit

The flanges are folded to make a lock joint on three sides of the patch. The fourth or lower edge of the patch merely overlaps the original roofing.

Several coats of good roofing paint should be applied over the patch and around the edges.—G. A. LEEDS.

Building Airplane Models

Standard Types—Tools and Materials Needed

By J. Danner Bunch *and* Avison F. Koch

TO FLY airplane models that you have built yourself is thrilling sport. You can hardly imagine the fun it is until you have tried it. The take-offs, the flying and the landings are all of breath-taking interest. Even more so is the participation in the airplane contests conducted by many model airplane clubs.

Fig. 1. Twin-pusher racing model (in foreground) single surface wing panels, fuselage for hand-launched tractor; girder fuselage for "R.O.G." pusher with geared propeller intended for three motors and double surface wings of 36-in. span; R.O.G. pusher (in rear)

At the outset it is well to familiarize yourself with the standard types of airplane models which are flown in contests and made by the majority of experienced model makers.

The simplest of all is the pusher plane with a single propeller (Fig. 2). It is usually a tiny ship with wings 2 ft. across and a stick for its body, or fuselage. It has no undercarriage and is launched from the hand.

The tractor plane with a single propeller in front is

(*Continued on page 181*)

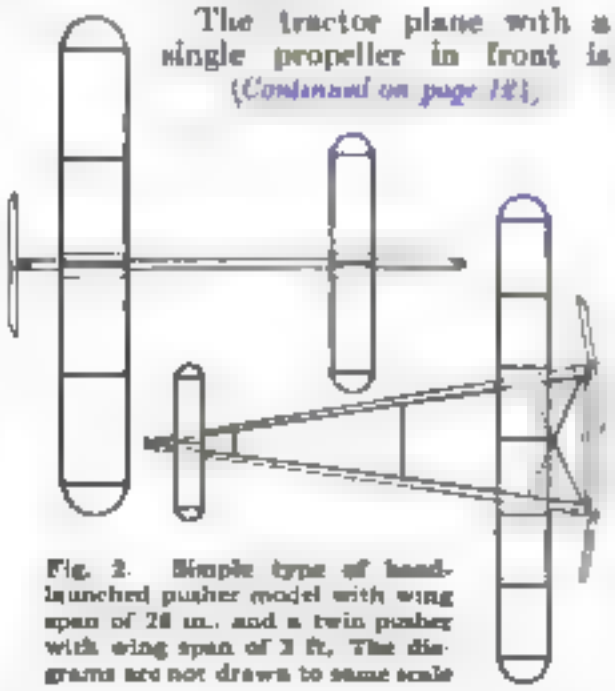


Fig. 2. Simple type of hand-launched pusher model with wing span of 28 in., and a twin pusher with wing span of 3 ft. The diagrams are not drawn to same scale

Airplane Models

(Continued from page 185)

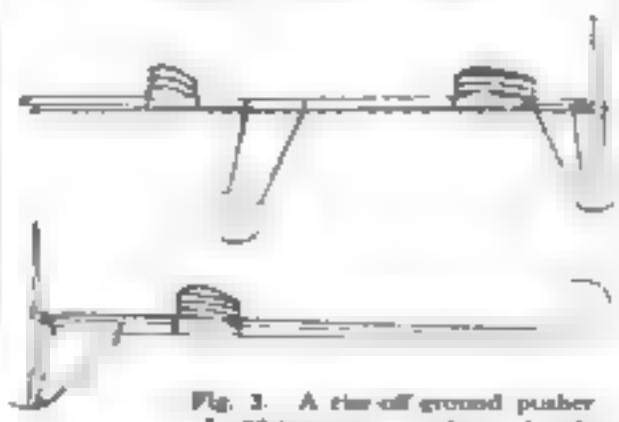


Fig. 3. A rise-off-ground pusher of 24-in. span and a hand launched tractor of 40-in. span

another model easy to build and offers interesting possibilities. One of these is illustrated in Fig. 3. The writers have seen these in various designs and sizes, some 6 ft. across, and have witnessed wonderful flights made by them.

The most remarkable flier of all is a twin-propelled pusher (Figs. 1 and 2). Some of these will fly a mile, and the writers have seen flights of two miles.

Although these models are of the hand-launched type, they may be equipped with pontoons for taking off from and alighting on the water.

Other models shown in the accompanying diagrams are a rise-off ground (commonly written "R.O.G." by model makers pusher (Fig 3), a geared R.O.G. tractor (Fig. 5), and a tractor model with compressed air motor (Fig. 6).

Beautiful models can be constructed that resemble full size airplanes in flight, such as the flying model of Lindbergh's plane described in October. Incidentally, a blueprint can be obtained for that plane. No. 6B on the list on page 104. Carefully designed and constructed models of this type can sometimes be flown under favorable conditions for half a mile. The take-offs and landings are most realistic.

Fig. 4. Knife and plane used for model making

The models driven by compressed air motors of the rotary or stationary type are the most elaborate ordinarily built. The writers have seen excellent flights by a 6-ft. monoplane with six-cylinder motor turning at terrific speed and buzzing like a giant bee.

The materials for model building are inexpensive and only the simplest tools are necessary. A good assortment consists of a small (Continued on page 123)

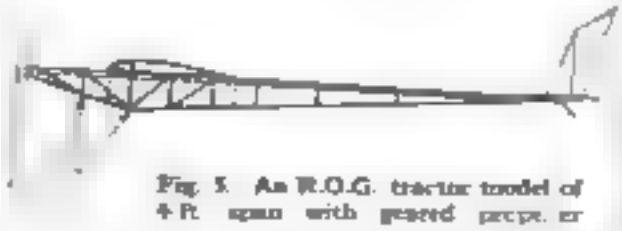


Fig. 5. An R.O.G. tractor model of 4-ft. span with geared propeller

Airplane Models

(Continued from page 124)

bench vise with 2-in. jaws, a hand drill with 1/16, 1/8, 3/16 and 1/4 in. twist drills, a light claw hammer, a small triangular file, ruler, a pocketknife for carving propellers, a 1-in. block plane (see Fig. 4), a pair of small, long-nosed pliers with side cutters, and a pair of shears.

All necessary materials can be obtained from dealers in model airplane supplies. For wing spars, longerons and braces, one can obtain white pine from any planing mill and cut it or have it cut on a small

Fig. 6. Tractor monoplane of 6 ft. span, driven by a compressed air motor

bench saw to the required dimensions.

Ribs, nails and outline pieces are best made of bamboo. The most desirable quality of bamboo for model making is to be obtained from the model supply houses; that is true also of rattan for undercarriages. These dealers also sell bamboo paper for covering wings, airplane wing varnish, commonly called "dope," rubber for motors, and, of course, all sorts of ready-made accessories and tools. Silk thread, china silk, glue, bicycle spokes, piano wire, spool wire, brads, pins and washers are easy to get.

If there is no model club in your own locality, you will find it a simple matter to organize one.

Races can be held to determine the best designs and construction. Tests for distance are always measured in a straight line from the starting point. Duration contests are held to see which model can stay aloft the longest.

It is important, of course, to classify the races carefully as to pushers and tractors, and rise-off-ground and hand-launched models. The barest rule for any test is to allow each entrant three flights in each event and count the best one.

The charter members of the club should formulate rules to govern races and the admittance of new members. A condition should be laid down that new members are admitted for a limited period and can become regular members only when they have constructed and flown a model that conforms to the club's regulations.

AN ARTICLE in the January issue will give a number of hints in regard to the construction of standard models.

If you wish to start building immediately you will find complete instructions in the March, 1925, issue of POPULAR SCIENCE MONTHLY *for making a simple pusher model with twin propellers something like the racer shown in Fig. 2. An article on the construction of an R O G tractor monoplane, designed by Mr Bunch, was published in September, 1926, and one on a 3-ft flying model of Lindbergh's plane in October, 1927. These back issues can be obtained as long as the supply lasts for 25 cents each. Supplementary blueprints are available for the tractor monoplane and the Lindbergh model. They are Nos. 50 and 69 in the* POPULAR SCIENCE MONTHLY *series. See the coupon on page 102*

How I Made a Desk

(Continued from page 51)

through a bit. This is a filler coat and the only way to make a perfectly smooth surface is to rub enough to cut off the high points of the surface. Apply a second coat in the same way and rub it lightly with No. 0 paper.

On this desk the next coat was white lead ground in oil, thinned with turpentine only and tinted with a very little medium chrome green and a little raw sienna, both colors ground in oil. The color was light pea green. One coat was applied and allowed to dry twenty-four hours. It was sandpapered lightly with No. ½ paper. Another coat of the same paint was applied after adding dry whiting to it, a handful to a quart of paint.

THE object of adding whiting is to enable you to stipple the paint to a fairly rough surface. The second coat is put on a bit thicker and while wet is pounded all over with a stippling brush as in Fig. 3. This is a brush 4 by 5 in. with very long bristles. Any long bristled brush or a flat wall brush, preferably of the 4-in. width, can be used to stipple paint. It must be used like a hammer, however, to pound the surface with the ends of the bristles. The normal stroke, from side to side, will not do it. Allow this coat to dry two days.

The glaze-stain is simply a mixture of raw umber, ground in oil, and turpentine. Raw umber is a semitransparent color and for a glaze should be mixed thin. Brush it over the stippled surface fairly evenly. While wet take a wad of cheesecloth and wipe the glaze in vertical stripes as noted in Fig. 4. Allow the fingers to bear down hard to make the streaks. Try it once or twice for practice. Then wipe off and make a clean start and a clean finish. The stripes usually run the long way of the surface, as on the sides, but on the base molding they were drawn horizontally.

In the glazing process you will see the advantage of having stippled the undercoat. The glazing color sinks into the deep pits and is removed only from the high points by the wiping. This produces a two-tone finish. The method may be done in any color combinations wanted as long as you use semitransparent colors such as (Continued on page 131)

Decorating Gifts

(Continued from page 74)

object and twirling until the entire inside is colored; the excess lacquer is then poured out. By pouring in two colors, a unique streaked effect is obtained. The pour finish is not wasteful, surplus lacquer is poured back into the can. Vases so decorated cannot be used for flowers; standing water may loosen the paint.

Spraying allows the amateur to produce many shaded and stippled effects. Inexpensive sprayers for the purpose are sold by some paint dealers, and an ordinary insecticide spray gun may be used.

Regular brushing lacquer may be sprayed quite satisfactorily with this equipment by reducing it from ½ to ⅓ thinner, which must, however, be made by the same manufacturer as the lacquer. Some practicing should be done to learn the manipulation of the sprayer, and the spray should be used rather cautiously.

Frosting is a pleasing effect, which may be obtained by blowing gold, aluminum, green or copper bronze powder from a paper onto an enameled or lacquered surface while it is still wet. On a lacquered surface it is necessary to work speedily before the quick-drying lacquer commences to set.

Texturing colored prints is another new idea. Fine prints such as are found in magazines or bought at a nominal cost can be given an appearance closely resembling that of an oil painting.

Lay the print, picture side up, on a clean, perfectly level surface, and place a piece of cheesecloth over it. (Continued on page 134)

Restoring Antiques

(Continued from page 66)

little crowning (convex) in the center to avoid digging in with the corners. If places are found that are still hard, do not dig at them: pass them over and apply another coat of remover.

For carving, fluting, beading and fine moldings, use a stiff bristle brush, but not a wire brush. From turnings such as chair rounds, posts, columns and spool beds, remove the softened finish with coarse burlap, using the same method employed by a bootblack in shining shoes.

IF, AFTER the first operation with remover, the surface seems to have retained some of the old coating, apply another lighter coat of remover and rub off in about five minutes with steel wool not coarser than No. 0. This is always necessary with carvings and turnings, and sometimes must be again repeated.

The corners and very close places will be found still to contain the loosened varnish and steel wool. Don't scrape or scratch this out with metallic instruments, but make the necessary tools from pieces of hard wood sharpened to a chisel edge or pointed, and covered with cloth. Move from one part of the cloth to another as it becomes foul.

To clear the wood from all remover, rub well with turpentine, benzine or gasoline, preferably the first. A cheap substitute for turpentine satisfactory for that purpose, is what is often called petroleum spirits.

If it should be found necessary, after the old finish is removed, to do scraping, first apply a coat of pure kettle-boiled linseed oil, diluted with an equal part of turpentine. Let this dry into the wood and it will be found that not nearly so much scraping is necessary.

WHEN buying varnish remover, be sure to obtain a high grade product made by a reliable manufacturer. It is not difficult to make your own remover at about one third the cost of first-class prepared removers, but do not attempt it unless you know how to heat highly inflammable liquids and are prepared to take all possible precautions against fire. For making an excellent remover use 3 pints each of benzol, acetone and denatured alcohol and 1 five-cent cake of paraffin wax. Heat the alcohol as hot as possible in a double boiler, and add the wax, shaved fine. Mix the benzol and acetone cold and heat to a point sufficient to melt wax. Pour the ingredients into one container and shake them well. Then let the remover cool. Always shake well before using. More or less may be made by increasing or decreasing the amounts proportionately.

No filler of any kind is needed after an old finish has been removed, neither is stain required. The proper finish for an antique, in my opinion, is the natural wood.

Any necessary repairing, patching and gluing should be done before the old finish is removed. These and the methods of doing the final finishing will be discussed in future articles.

If dust covers the patina is an interesting subject. According to the Forest Products Laboratory of the U. S. Department of Agriculture it seems probable that it is a change in the physical condition, possibly resulting from a photochemical reaction, in the part of the wood that is near the surface.

TO FASTEN light removable fixtures to a cement wall or floor is not difficult. Obtain some wire that is about equal in diameter to the pitch of the threads on the bolts to be used and wind a length of wire around each bolt in the threads. Drill holes in the concrete, place the bolts and pour cement around them. When the cement is hard the wire will be held firmly and the bolts can be removed or replaced.

MAKE MORE MONEY READ MONEY MAKING OPPORTUNITIES ON PAGES 146 TO 170 OF THIS ISSUE

Paper Models Help Design Stage Settings

(Continued from page 82)

to be used should be rather heavy and stiff. Cardboard is almost too thick for convenient handling; besides, the folded edges are apt to crack and open up. I have found that in general a gray or light brown "cover paper" is most useful; it will take water color and with the use of tempera, or "showcard" colors, substantial effects can be obtained which suggest the finished sets far better than the use of the ordinary water color washes.

Windows and door openings can best be cut with a sharp penknife over a sheet of glass. The window divisions can be suggested with string or heavy thread fastened across the window openings, on the back of the drawing, by means of narrow strips of sticker tape. It will be well for the scenewright to keep handy a roll of this paper fastening-tape, the kind that is now generally used in stores for the binding of packages. This paper is more useful than paste, not alone for joining sheets of paper, but also for securing the side walls of the model to its base or floor.

If your set calls for a backdrop, a country or city view seen through a window, and if the scenewright is unable to make the sketch himself, he can usually find among the advertising pages of magazines suitable colored pictures. Sections of these will answer for the backdrop of his model and may also serve him later as a suggestion for the actual backdrop. Colored post cards are also useful as views from small window openings.

In fact, the scenewright after only a little practice will invent for himself all manner of ways of making his small models look like miniature rooms. He will find that tables and chairs can be cut from paper and folded into lifelike imitations of the real thing. And later on, when the actual sets are built and he sees them through the proscenium arch, they will offer him no shocking surprises in the way of omissions and accidental conflicts, but instead he will be looking into a now familiar room, and recognize it as his own model grown up.

Wood Filler Gives Two-Tone Effect

THE use of light or aluminum colored paste wood filler to obtain a weather-beaten or silvery finish on oak and other open grained woods is well known to many home workers, but few amateur painters and decorators realize that many other novelty effects may be obtained in a similar way.

For example, chestnut or oak may be stained with a light oak stain and then filled with paste wood filler tinted a dark blue. A dark oak stain may be used and the filler tinted with Venetian red, or a forest green stain, followed by a gray filler made by mixing white lead and a minute quantity of lamp black with the paste filler.

In all cases it is best to use dry pigment to color the filler, which should be applied and rubbed off across the grain, just as if it were in its natural color.

After the filler has dried for 24 hours or more it is given a coat of thin shellac and may be followed either by varnish or wax.

If a door sticks on its front or lock edge, do not plane the finish off. Instead, take the door off the hinges, remove the hinges, and plane enough off the back or hinge edge to allow the door to swing freely. Then cut an equal amount from each hinge bed and rehang the door. Perhaps the hinge joint may be open enough so cutting the hinge bed will be sufficient. If planing is necessary, finish the back edge of the door and no one will suspect that a piece of repair work has been performed.

companion adventurers might well be hung on the palisades. Thus, although we are not going to make a seventeenth century, brand-new carnival kind of ship, ours will be equally beautiful, if not more so, than the usually accepted model.

After exhaustive research, the writer believes his model is of a ship such as Columbus might, and probably did, use in making his famous voyage. No smallest detail or touch of color has been embodied without reason. For example, the shade of the blue used on the loopholed bulwarks is not there because it is pretty, but because it is the hue that was used on ships for centuries, and is at ll to be found in the flags of Catholic countries, as the "blue of the Virgin's robe.

HAVING given my reasons for this *Santa Maria*, instead of the all too common one usually seen, we may get to work, feeling confident that the result will more than compensate for the time and care involved. The model looks complicated, but if the plans and instructions are followed and troubles are not anticipated, it will be found to work out quite simply

Full size drawings are essential, but these you can obtain by sending for Popular Science Museum blueprints Nos. 74, 75 and 76. Use the coupon on page 106

The tools required will be the usual domestic kit, with a jig saw, a fret saw, spokeshave, half-round file or rasp, small round-nosed and cutting pliers, some small C-clamps or spring clothespins, a light hammer, small nail set, tweezers, and some very small wire twist drills with a handle. A set of die-sinker's files are useful, as is a jeweler's saw

The material needed will be referred to as the work proceeds. Little need be bought excepting the pine for the hull, the reed spline and a few dowel sticks, with cord, wire and canvas for the rigging: indeed, five dollars should cover all the material. A complete bill of materials will be found on Blueprint No. 74

The hull is made of a series of layers or lifts, so first we must have full sized drawings of each of them. These may be enlarged from the plans given in Fig. 1, but Blueprint No. 74 gives them all drawn to the full size required for a model with a 10-inch hull and an overall size of 25 in. long and 21½ in. high.

Clear white pine is the best wood. One board ⅝ by 8½ in. nominally 8 in.) by 14 ft. 0 in. will be sufficient. On this draw the outlines of the lifts A to N, of which A to F extend the full length of the vessel, G, H and J are short pieces at the bow and those from K to N are half length lifts at the stern end. It will also be noted that the hull is at its widest at lift E, and from there "tumbles home," or narrows, as it rises, nearly all its midship length.

ON EACH lift before cutting, mark the midship line and the necessary cross lines I to VIII., extending them over the edges. With the fret saw or hand saw and spokeshave, cut each piece to size. To reduce the weight and make the hull less liable to warp, lifts B to E may be hollowed to within ½ in. of the outline of the lift immediately below. Lifts G, H, K also may be hollowed. Glue together lifts A to F, being careful that the construction lines coincide. Leave this block clamped or heavily weighted for a day

From a piece of cardboard cut a series of templates to the lines of the bow and stern profiles (sheer plan) and to the body lines (body plan), marking on each where the lower edge of lift E cuts them.

Cut away the projecting corners from the block until the bow and stern templates fit it at the ends. Shave down the center of the top to the deck line, (Continued on page 130)

The True *Santa Maria*

(Continued from page 82)

The True *Santa Maria*

(Continued from page 129)

and shave away at the ends until your templates nearly fit when held at their respective construction lines (I to VIII).

Glue on the bow lifts G H J and the stern pieces K to N. Note that the lower edge of L follows K upwards, but that the upper edge comes sharply out to coincide with piece M (see the body plan at Line VIII). Piece M starts at line VI, and piece N ½ in. abaft line VIII. Cut the upper-deck-line sheer on these and then shape the whole up to the templates. If your lifts are cut properly to shape, this should be a matter of shaving away the projecting corners until you have a smooth surface with easy flowing lines. The ends should be flat and ¼ in. across to take the stem and sternposts.

FROM ¼-in. wood, cut a keel, stem and stern. This is more easily made in three pieces, joined as shown. Glue and nail on these pieces firmly. Make a bracket for either quarter from ¼-in. wood as shown at O, cutting away the hull so that the forward, upright edge of these pieces is flush with the main hull. Glue and nail these in position.

To the line q cut a rabbet, a bare ⅛ in. deep, and to the line r along the stern do the same. Into these rabbets fit white pine bulwarks Q and R, ¼ in. thick. Try these out in cardboard before cutting the wood. Glue and lightly nail them in position, then cut their top edges to the lines, making sure that both are the same height. Along the after part set in similar ¼-in. strips R. Sandpaper all flush with the hull. The parts R extend forward over Q ending in the one curve clamp them together here until the glue dries, and reinforce, if desired, with a pin used as a nail.

Sandpaper the deck smooth and mark the deck planks with a very hard pencil. The lines should run truly fore and aft at about ¼-in. intervals.

Across the after bulkhead there will be an overlay S of any hard wood such as mahogany or cut from a cigar box. It should be as thin as possible. Mark or carve on it a center door flanked by windows. The latter can be cut right out and backed with pieces of celluloid or mica. This piece is glued and lightly nailed on. A similar piece may be made for the forward bulkhead, but with no show.

Similar overlays should be made to glue onto the poop sides T, each with six ⅛ in. sq. windows, two between each of the four after sheds. The photographs show them all the way along, but that may be too many and the drawings should be followed. Across the forward end of the after deck glue a thin strip to cover the joint, and along the after bulwarks a similar but wider strip, flush inside but projecting ⅛ in. outboard.

ACROSS the stern is overlay U. This may be plain with the exception of two little doors. It is possible, however, that because Columbus named his ship Santa Maria, one of his few friends at court may have given him a painting of the Madonna which he fastened to the stern of his ship. Suitable little pictures may be bought. This piece is nailed flat; the top rail continues over it and similar pieces cover the side joints.

The raw bridge, or midship half-deck, comes next. This is best made of thin three-ply wood, but can be of thin pine about ¼ in. thick, with the grain athwart. It lies along the bulwarks until it reaches the after curves, from where it runs straight to the after bulkhead. Its shape will be seen in the deck plan (Blueprint No. 76). It is planked-marked across, butts up to the forward bulkhead, and has an extra support underneath with some posts glued to the bulwarks and four posts under the inner edges. If of pine, it had better have a thin batten glued along the

(Continued on page 151)

The True *Santa Maria*

(Continued from page 130)

inner edges to prevent splitting when bent to the sheer of the bulwarks.

The wales, or longitudinal strengtheners, should now be glued and nailed on. These also may be of pine, but rattan, reed or cane, such as is used by chair mekers (they call it spline, for fastening woven cane seats in place, is better because it bends easily without steaming. Nearly 20 ft. of this will be wanted, $\frac{1}{8}$ in. thick and $\frac{1}{2}$ in. wide. Their position is shown in Fig. 6. The first one starts at the curl of the stem, comes level with the top edge of the cow bridge at station point III, and continues to the stern at the lower edge of the poop overlay. The others are parallel, except that they are slightly closer at the ends.

IN BETWEEN these, plank marks may be scored with a sharp point. The upright skids are half-lapped skid and wale being notched so that they set in almost flush. They are spaces of the same size. Note that the midship ones are almost upright, but that the others slant more and more as they work fore and aft. If they are fastened with round-headed nails, such as escutcheon nails, the effect is good. The short pieces at the forward end of the cow-bridge are set in between the skids.

We have now done all the heavy work. If you have finished this before the next issue appears, you can give the lower part two or three coats of flat white paint up to the water line (top edge of D_1), the deck a coat of light brown stain, and the rest of the hull some darker stain. The final coloring will come later. You can also make a temporary base in which to hold the model upright. Such a base may be seen in the illustration at the top of page 82. The top part revolves on a peg in the lower.

Next month Captain McCann will tell how to complete the hull and make the small fittings.

How I Made a Desk

(Continued from page 130)

raw and burnt umber, raw and burnt sienna, Prussian blue, ultramarine blue, cobalt blue, chrome green, American vermilion, or mixtures of these colors. Yellow ochre, lampblack, chrome yellow and white lead are not glazing colors because they are too opaque. To make gray glaze finishes, mix raw umber and ultramarine blue and use over a white ground.

A great number of two-tone effects may be had by using these glaze colors over the same or various light colored grounds. For instance, the same ground coat color was used on the interior of this desk, but the glaze color used was American vermilion instead of raw umber. A totally different effect was gained.

After the glaze-stain coat had dried about forty-eight hours, a coat of clear brushing lacquer was applied. Varnish could have been used, but the lacquer is more transparent and, therefore, did not give a yellow cast to the surface as would have happened if varnish had been used. The brushing lacquer was applied the same as varnish with an ordinary $2\frac{1}{2}$-in. varnish brush.

In an article scheduled for early publication, Mr. Vanderwalker will tell how he made the hand-wrought hinges for the desk from common barn door hardware and finished them with silver leaf. Readers of POPULAR SCIENCE MONTHLY *who happen to be painters and decorators will recognize Mr. Vanderwalker, or "Van" as he is familiarly known, as one of the leading authorities in their own field and the author of "Interior Wall Decoration," "House Painting Methods," "Wood Finishing" and other books. He will contribute regularly hereafter on subjects of interest to amateur painters.*

Metal Work for Beginners

(Continued from page 80)

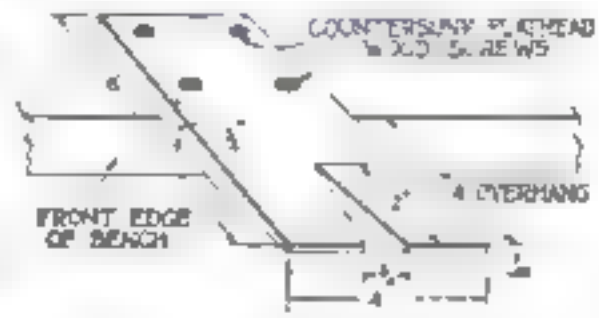


Fig. 6. If it is not convenient to mount bench pin by mortising, screw it on

the axle of the treadle has much to do with the ease of operation; it is best to try several points in relation to the distance from the hinge end of the treadle before finally screwing it in place.

When an old balance wheel is used, some sort of a shaft and crank must be rigged up. One way is to obtain a piece of shafting slightly larger than the hole in the wheel and forge or have forged a crank at the end, and then mount the piece in a lathe and turn down the shaft to fit the wheel (A, Fig. 1). Another method is to find or buy a disk crank (B) to fit the wheel shaft and drill a hole for a bolt. Two nuts, one on each side of the disk, hold the bolt, while the head of the bolt holds the connecting rod. Perhaps a regular crank-shaped piece may be obtained and held to the shaft with set screws.

The simplest method probably is to drill a hole on one side of the hub of the wheel (D) and tap it for a bolt. A piece of iron pipe is used for a bushing to keep the connecting rod from striking the wheel.

The crank and roller bearings sold for mounting grindstones sometimes make an excellent mounting for a foot wheel.

It is quite important not to have too great a throw between the center of the shaft and the crank pin. A large throw will result in an exaggerated foot motion. The distance of the throw of the crank shown in Fig. 1 is 1¾ in., which is ample for an 18-in. wheel.

Much work may be done with a ¼-h.p. polishing motor of the kind that sells at from $30 to $35. Larger work requires a motor of from ½ to 1 h.p. or more. For very large bowls and trays, you will find that you will need at least a ½-h.p. motor although much depends on the size of the polishing wheel used and the skill of the operator.

If you already have a small electric motor about the shop, say a ¼-h.p., you may rig up an excellent little polishing head by mounting the motor and the head on a board or on the bench and connecting them with a sewing machine belt.

When a foot- or power-driven lathe fitted with a drill chuck is available, you may use this as a polishing head, or as a grinder, for that matter. The head may be sawed off a large wood screw and the shank of the screw held in the drill chuck on the lathe; then, using a flat file or a lathe tool, turn off a part of the screw threads in a taper so that just a part of the original thread shows at the point of the screw and the full thread is left at the shank (see Fig. 4). On this you may screw polishing wheels or buffs, and the taper thread will hold them in place as they revolve.

Also, it is quite possible to get attachments which fit on the end of small motor shafts, one for holding emery wheels and another with a taper thread for polishing wheels. These convert a plain motor into a polishing motor at small expense.

If you have gas piped to your shop, you will find it most convenient for a soldering blow torch driven by a foot bellows, for Bunsen burners, and for a small gas plate. The gas should be piped, if possible, along the soldering bench, with

(Continued on page 133)

Metal Work for Beginners

(Continued from page 132)

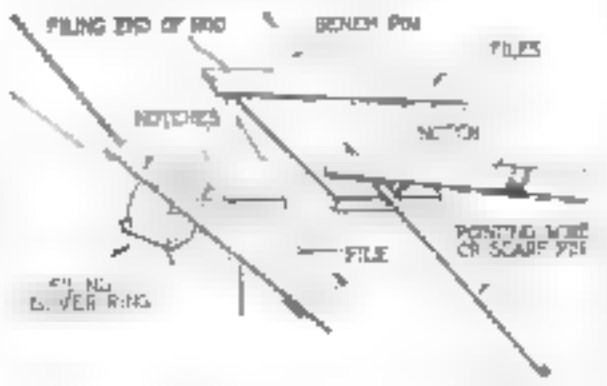


Fig. 7. Three types of jobs where the bench pin is useful for holding work

three outlets or socks for hose connections At your smaller bench for light work, if you have one, two connections will prove useful. one for a small gas blowpipe and the other for a small Bunsen burner

If you live in the country, as I do, you will find that a plumber's gasoline blowtorch is an excellent source of heat for large work properly set up in the soldering box. I have two of these torches and frequently use both of them at once, one in each hand.

For my small soldering, I use an alcohol blowtorch, and for this the current of air is furnished by blowing through a tube I use the lamp from an old chafing dish as a Bunsen burner, and as a jeweler's soldering lamp with a ball-shaped glass fount which may be turned about in its socket to make the flame convenient for blowpipe or other work.

When fitting up a shop for metal working, you should provide some place for scrubbing your work. Almost all work that is annealed or hard soldered is scrubbed with a brush wet with water and charged with powdered pumice stone to remove traces of the pickle and any dirt A piece of flat board may be laid on the bench and the work scrubbed on it, or a wooden box may be placed near the sink, if you have running water in your shop. The reason a scrubbing board, box or bench is needed is because you must have some place where the spatter from the scrubbing brush will not fly on to your tools or work, for wet pumice very quickly rusts steel and stains copper

The construction of the simple but very much used bench-pin is shown in Fig. 8. This is made of hard wood. It may fit in a mortise in the front of the bench, as shown in the first article in this series (page 119, November issue), or it may be a single piece of fairly thin hardwood screwed to the bench as shown in Fig. 6. The methods of handling work illustrated in Figs. 7 and 8 may very well be adopted by the model maker as well as those interested in jewelry or other light metal work.

This is the second of a series of articles by Mr. Thatcher on decorative metal work for amateur craftsmen The third, which gives plans for a completely equipped shop, is scheduled for early publication.

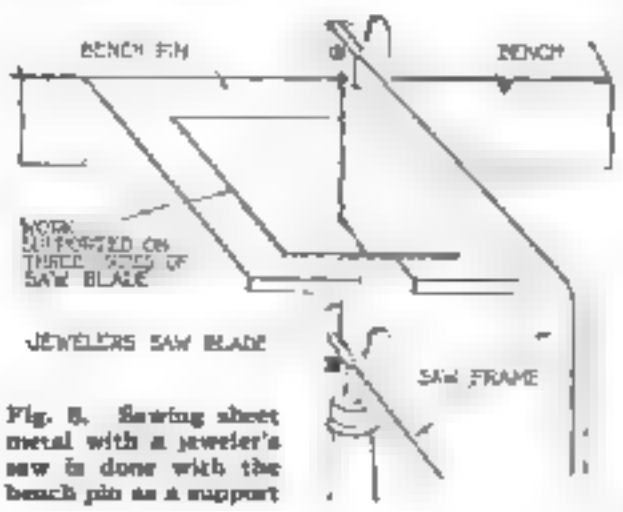


Fig. 8. Sawing sheet metal with a jeweler's saw is done with the bench pin as a support

This seal on a radio, tool or all burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Lighting Your Tree

Continued from page 78

cord belt. A rheostat can be mounted near the motor for regulating the speed

At the rear of the top of the disk, arrange a magic lantern lens close to the colored windows so the rays will be thrown directly through them as they pass by. In case a lantern cannot be procured, an automobile headlight can be substituted after cutting down the lens opening with a suitable mask to match the opening size in the disk

This outfit can be built to use either 110-volt apparatus or to operate from a storage battery. Mount it on a suitable shelf at the other side of the room and then, after lighting the projector, start the motor. The slowly revolving disk will continuously and automatically change the color of the light thrown upon the tree. With the proper arrangement of colors on the disk and an even speed, the effect can be made magically beautiful in a darkened room

Have you a few of those ever-present hollow ornaments that you hesitate to use because the tops are broken off? If so, here is a way you can give them a new lease on life and brighten the decorative effect of the tree. Cut the neck of the ornament off with a sharp knife so that the opening is wide enough to admit a Christmas tree bulb as in Fig. 3. Then wrap adhesive tape about the socket and the top of the ornament and cover it with a narrow strip of decorative paper. Such translucent ornaments, when illuminated from the inside, are highly pleasing

PERHAPS you cannot obtain a sufficient variety of colored lights where you live. Then here are methods of dyeing plain glass bulbs. The process is simple and inexpensive

Soak a small quantity of gelatin in cold water until well softened. Then boil and strain through very fine cheesecloth. While this preparation is still hot, add sufficient aniline dye to give the required color. The dye should be made into thin paste with water before adding to the gelatin. When the gelatin is thoroughly impregnated with color, dip the bulbs in it and stand them vertically to dry.

Another way is to dissolve several old photo films, from which the gelatin has been removed, in a solution of equal parts of ether and alcohol. Add the dye and dip the bulbs as before. This coating is waterproof

These ideas can, of course, be easily modified or improved by anyone with inventive ingenuity, and it is hoped they may lead to many pleasant surprises this year in the way of Christmas tree illumination

Decorating Gifts

Miscellaneous Items, page 208

Then apply a coat of shellac over the cheesecloth, brushing it out evenly and thoroughly into the meshes. As the shellac dries, it will cement the cheesecloth to the print. The texture gives a surprising softness and richness to the print and makes a truly artistic picture, which can be framed, passe-partouted or mounted on a plaque and polychromed, as desired. It may be used without glass, as the shellacked surface will permit wiping off with a damp cloth whenever necessary

The cheapest grade of cheesecloth, very sleazy and with wide meshes, should be used. The better grades, which are closely woven, hide the picture too much

The cheesecloth should be shaken just before using to remove loose pieces of lint. In some cases the shellac "bleeds" the colors in the print and causes them to run a little, but this is seldom objectionable. The colors generally seem to blend together so that the effect under the meshing is quite delightful. If the picture does not show through plainly enough, apply a second coat of shellac.

Statement of Ownership, Management, Circulation, etc., required by the Act of Congress of August 24, 1912, of Popular Science Monthly, published monthly at New York, N. Y., for Oct. 1, 1927. State of New York, County of New York, ss. Before me a Notary Public in and for the State and county aforesaid, personally appeared [illegible] who, having been duly sworn according to law, deposes and says that he is the Business Manager of Popular Science Monthly and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Popular Science Publishing Co., Inc., 250 Fourth Avenue, New York, N. Y. Editor, Sumner N. Blossom, 250 Fourth Ave., New York, N. Y. Managing Editor, [illegible] 250 Fourth Ave., New York, N. Y. Business Manager, G. B. Capen, 250 Fourth Ave., New York, N. Y.

2. That the owners are: Popular Science Publishing Company, Inc., 250 Fourth Ave., New York, N. Y. Stockholders of Popular Science Publishing Company, Inc.: H. G. J. Pfaher, 28 William Street, New York, N. Y. Oliver H. Capen, 250 Fourth Ave., New York, N. Y. Robert Lyle Wilson, Old Springfield Ave., Maplewood, N. J. Ada H. Wilson, Old Springfield Ave., Maplewood, N. J. H. Duggan, 6 N. Michigan Ave., Chicago, Ill. A. J. Cole, 250 Fourth Ave., New York, N. Y. Godfrey Hammond, 250 Fourth Ave., New York, N. Y. Publishers Publishing Co., 25 Church St., New York, N. Y. John Nichols, 250 Fourth Ave., New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of the total amount of bonds, mortgages, or other securities are: None.

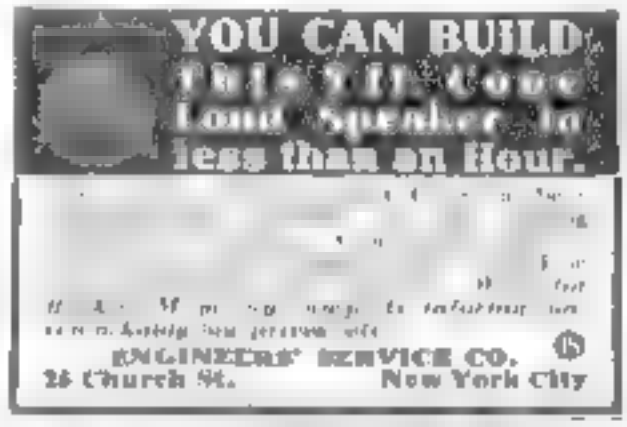
4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) H. G. Capen, Business Manager.

Sworn to and subscribed before me this 22nd day of September, 1927.

(Seal) [illegible], Notary Public, New York County, New York County Clerk's No. 367, New York County Reg. No. [illegible].

(My commission expires March 30, 1928.)



ENGINEERS' SERVICE CO.
25 Church St. New York City

BUILD THE REAL SANTA MARIA

Our special construction set modeling in all necessary material such as sandblasted hull, all deck materials, rigging, flat sail cloth, finished metal guns with mountings and numerous other requisites with save you a great deal of time and assure an expert model. Our new catalog describing this set and showing reproductions of actual photos of original models with prices of hulls, blocks, dead eyes, guns, etc., for all Popular Science models sent postpaid upon receipt of 10 cents.

SHIP MODEL SUPPLY CO.
Dept. S Mineola, N. Y.

ZIP-ZIP SHOOTER
CAMPERS AND TOURISTS:

Here is the very thing for you. Fresh game will be the order of the day if you have a Zip-Zip Shooter in readiness. Powerful and effective and is used by a great number of trappers and campers. Thousands of boys are now happy with this wonderful [illegible]. Ask your dealer to show you the Zip-Zip. If he does not have it, send direct to us. Send stamp for [illegible] catalog.

Automatic Gunner Co.
Dept. S.S. Columbia, S.C.

RADIO AGENTS
Make Big Money

EASY to sell American Radios and Supplies. Extremely advertised, highly quality merchandise at wholesale. Big profits on every sale. No capital to invest. No push to carry. Order direct from our huge warehouses as you sell.

Get My Liberal Offer and our Big New 192-page Catalog and Dealer "How to Sell Radios" Free. Full of the newest all latest in Radio. Write today.

AMERICAN AUTO & RADIO SUPPLY CO.
"EVERY SUPPLY ANYWHERE, ANY"
Dept. 333 American Radio Bldg., Kansas City, Mo.

BIG RADIO CATALOG FREE

This seal on a radio, tool or all human advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Ball Bearings Used as Wheels for Scooter

IN LESS than an hour's time the scooter illustrated was made from a few scraps of crating and four discarded ball bearings. Such bearings are replaced in automobile shops when they show wear beyond a certain "tolerance," but for many uses are still quite serviceable. On this scooter, for example, they are far better than wheels from roller skates.

A scooter for a small child made from crating strips and four discarded ball bearings

The front and rear axles were made from short pieces of hardwood larger in diameter than the hole in the inside of the bearings. The ends were whittled to make a slight drive fit into the bearings, and a hole was drilled for a cotter for each bearing. The handlebar support is inclined backward at a slight angle; two short pieces on each side serve to brace it firmly.

The scooter shown has been in service for more than seven months, needing but a drop of oil occasionally in the bearings. The four points of support make it safe for even a small child.—SHERWOOD J. GEE.

A Screen for Home Movies

IN PLACE of a sheet or tablecloth, which so often is used as a makeshift screen for a small motion picture projector, it is possible for anyone to make an excellent silver screen. Any material that is plain white, closely woven and of a fairly heavy texture will do. oilcloth of the kitchen table variety gives excellent results. A good working size is 4 by 4 ft The other materials needed are clear varnish and aluminum powder

Apply the varnish very evenly with a brush (in the case of oilcloth, to the coated side). Allow it to set a little, but do not let it get too dry. Then apply the aluminum powder by shaking it through a piece of cheesecloth on to the sticky varnish. After it has dried, the excess powder can be shaken off

Attach two sticks to the opposite ends. The bottom stick should be round an old broom handle, sandpapered and painted, will do nicely

At a little extra expense the top can be attached to a spring shade roller and the hangers mounted on a board. —ALBERT L. SNEDAKER

How to Rig Up a Simple Telegraph Line

IF YOU wish to connect up a telegraph or buzzer line with the fellow next door or within two or three hundred feet of your own home, the accompanying diagram will show you how to do it in the simplest possible way. Only one wire is run between the houses, no switches are used, yet a pressure on either key operates both telegraph instruments or buzzers. The arrangement is of the open circuit type, so that no current flows except when the keys are pressed.

The parts consist of A and B, which can be either telegraph keys or any type of push button; C and D, each a battery of from one to three or more ordinary No. 6 dry cells, the number depending on the length of the line; E and F, ordinary bell buzzers or telegraph sounders. Bell wire

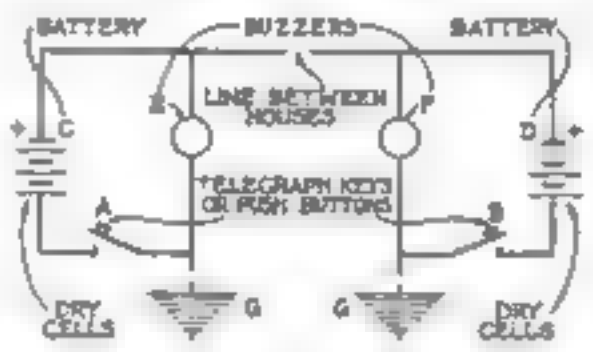


Diagram showing a short house-to-house telegraph or buzzer line, with no switches

can be used for all connections, although if you find it necessary to have the wire between the houses strung over 50 feet between supports, it would be desirable to use radio antenna wire at these points in the circuit. At each house a wire is run, as indicated by G, to a ground connection, preferably a water pipe.

When key A is pressed, current flows through buzzer E and also through F by way of the wire between the houses and the water pipe return. When key B is depressed, both instruments are operated by current from battery D. If a message is being sent from one end of the line and the operator at the other end desires to cut in, he presses his key and the buzzers sound continuously, or the arms of the telegraph instruments remain in the down position, so that the sender knows that the operator at the other end wishes to break in.

Make sure that the batteries are connected at each end with the positive toward the line between the houses, as otherwise there will be a direct short circuit if both keys are depressed at once.—A. P. L.

Cutting Odd Shapes in Glass

IT IS occasionally necessary to cut window glass into an irregular shape. Provided the edges do not have to be smooth and very accurate, the cutting can be done in a tub of water with tin snips or large scissors. Keep work and hands entirely submerged. The same result can be accomplished without water, although less easily, by breaking off minute pieces with pliers. For cutting circular pieces, it pays to buy a regular cutter made for this purpose.—J. C. H.

"Your Car Need Never Freeze"

(Continued from page 68)

away. "When a motor sticks like that from overheating," he explained, "it's because the piston has kept expanding until it won't slide up and down in the cylinder any more. Generally the cylinder walls get burned a bit but if the motor is just running idle as yours was, as soon as the pistons cool off they'll slide again, although sometimes they practically weld themselves to the cylinder walls and you're in for a fat repair bill.

"The compression seems all right," Gus continued, "so it's a safe bet that none of the rings broke, and if the burned streaks don't start it to pumping oil and fouling the plugs no damage has been done."

"That's something to be thankful for," agreed Madden, "but all the same I hate to go back to alcohol. It's such a blamed nuisance. Isn't there something else I can use to keep the radiator from freezing? You never know how much alcohol you've got. Every time the motor gets good and hot going up a hill a lot of alcohol boils away and the same thing happens even on level going whenever there's a warm day in winter."

"THAT'S true enough," Gus agreed. "Of course alcohol has its disadvantages. The low boiling point is one of them. On the other hand it is much better than the calcium chloride preparations because alcohol doesn't cause any corrosion—but why don't you use glycerine? I know it costs a lot more to fill your radiator with the proper mixture of glycerine and water when you start using it, but it really is cheaper in the end, because you can use the same glycerine year after year if you're careful. The glycerine in my radiator is three years old."

"Three years old!" exclaimed Madden in great surprise. "But doesn't it evaporate or get sour or something? If the motor gets hot doesn't it boil away?"

"You couldn't lose a drop by evaporation or boiling if you wanted to," Gus replied. "The only thing you've got to be mighty careful about is leaks in the cooling system. It wouldn't pay to use glycerine if the hose connections dribbled water or the pump packing gland leaked a drop now and then. You've got to have them absolutely tight. Glycerine is like kerosene in that it will seep through a crack that water can't get through.

"Glycerine doesn't evaporate at all in the ordinary sense, and it boils way above 212 degrees, so if the motor overheats, the water boils away and leaves the glycerine right in the radiator.

"THERE'S one point you want to watch out for. You may lose some glycerine if the motor boils so hard that the steam bubbles raise the level of the solution in the radiator high enough to force a lot of it out the overflow pipe. You can overcome that by slipping a piece of rubber hose on the end of the overflow pipe and tying the other end into an old tin can fastened beside the motor near the radiator. Then if steam blows off any of the solution, it will be caught in the can and you can dump it back in the radiator."

"Sounds good, agreed Madden. "Where do you get the glycerine?"

"You can buy it at the drug stores," Gus told him, "but it will cost quite a bit, because the glycerine they sell in drug stores is a lot purer than you need. Several brands of a lower priced glycerine refined especially for automobiles are for sale now. We carry a good supply. Want to try it?"

"I know the answer to that one," laughed Madden. "It's yes! And even if the car does smell like an old lamp from that confounded kerosene I'll know I'm not going to get another shower bath from it!"

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Marconi, Father of Radio

(Continued from page 137)

December twelfth, Marconi heard the signals faintly. At ten minutes after one came a succession of S's of unmistakable clearness. Once again Matrons thrilled to hear the clicks that day, and again the following noon.

Two days later the world was told Marconi had spanned the ocean. And, as Marconi fully expected, few believed it.

Modern engineers have called it a miracle that Marconi's crude apparatus was able to detect at all the feeble S's from the wheezy Poldhu transmitter—even present-day stations, they say, might have failed to catch them. Is it any wonder then that the startling announcement "OCEAN SPANNED BY WIRELESS TELEGRAPH" was met with skepticism in 1901?

To reporters, Thomas A. Edison, electrical wizard, said frankly, "I don't believe it." Dr. Lee De Forest, inventor of another system of wireless telegraph, doubted it.

IN BRITAIN, none dared deny the signals had been sent, but every one doubted their reception. Then two dispatches reached the press. The first

"ST JOHNS, N. F., SATURDAY CONFIRM THAT SIGNALS WERE RECEIVED HERE THURSDAY AND FRIDAY DIRECT FROM CORNWALL RECEIVING WIRE SUSPENDED BY A KITE. MARCONI

And the second

"SINCE MARCONI HAS STATED OVER HIS OWN SIGNATURE THAT HE HAS RECEIVED THE SIGNALS FROM ENGLAND I BELIEVE HIM AND I THINK THAT HE WILL CARRY IT TO A COMMERCIAL SUCCESS. IT IS A GREAT ACHIEVEMENT AND HE IS A GREAT EXPERIMENTER.

EDISON

Marconi went to England, and returning received on shipboard messages from Poldhu, 1,551 miles away. He set up a new station at Glace Bay, Nova Scotia, and exchanged messages with Poldhu.

Where Marconi led other inventors were quick to follow—Fleming with his "valves" and De Forest with his vacuum tubes, Alexander Graham Bell with his wireless telephone, Armstrong and his successors with their oscillating circuits. By 1921, only twenty years after Marconi's first trans-Atlantic test, broadcasting was a fact in America. A year later England, France and Germany had regular broadcast programs.

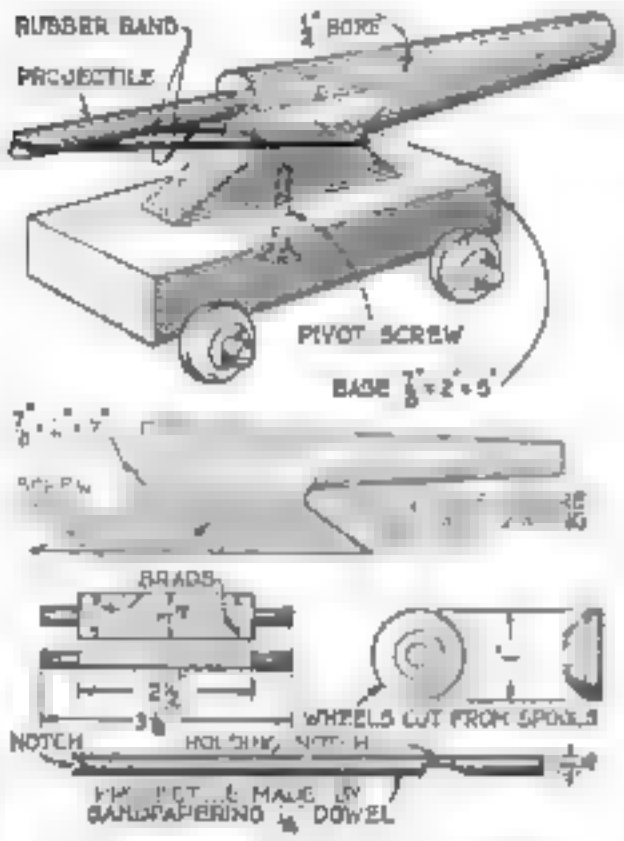
COMMERCIAL radio—for "radio" it had now become—was making tremendous strides meanwhile. In 1916, Marconi started investigating short wave radio and low-power, high-speed "beam transmission." As early as May, 1924, Marconi telephoned from Poldhu to Sydney, Australia, by beam radio, his voice being clearly received—a little-known event far preceding last year's trans-Atlantic phone success.

Now the new Canada-England and England-India beam radio links have shown their unlimited possibilities. An experimental line is to link New York and England. The new beam system has already handled 1,000 words a minute in laboratory tests, the inventor says.

The world is getting smaller through radio. An American motor car company recently dispatched a wireless photograph of its latest model to far corners of the earth. A motion picture producer in London has just bought the $225,000 movie rights to a New York stage success after a conference by trans-Atlantic phone; his actual signature was flashed across the sea by radio. Latest aids to international communication are the new Canada-London 'phone and direct radio service from New York to Belgium.

Easily Made Toy Cannon Shoots Accurately

SIMPLE as it is to construct, the toy cannon illustrated is one that can be swung around, aimed and shot with surprising accuracy. All that is necessary is a piece of wood ⅞ by 2 by 12 in., two thread spools, a thin piece of packing case, a few brads, a 1¼-in. wood screw,



The wooden gun ready to shoot, details of the parts, and one of the long projectiles

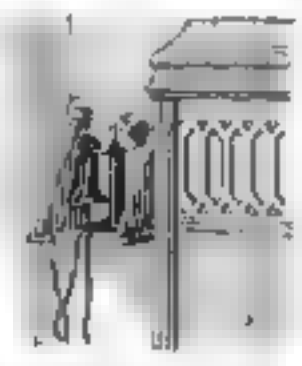
a ¼-in. dowel for the 6½-in. long projectiles, and a rubber band.

Targets can be made or the small celluloid animals for sale at nearly all ten-cent stores may be used. If you are skilful at sketching, soldiers, houses, trees and animals may be drawn on cardboard and cut out, or pictures from magazines may be suitably mounted.

The "range" is controlled by the addition of more rubber bands or the use of one of greater strength.

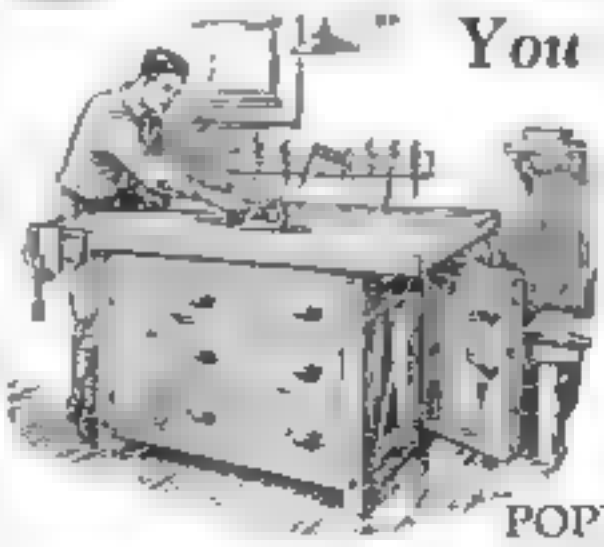
A coat of paint or brushing lacquer adds materially to the gun's appearance, or, better yet, a good job of "camouflaging."—WESTON S. ANDERSON

Neat Shelf for Telephone



Phone shelf partly hidden by furniture

A PHONOGRAPH cabinet in the living room was originally the inappropriate although convenient resting place for our telephone. To have placed the receiver in one of the elaborate telephone dolls or containers sold for that purpose would have entailed the trouble of lifting off the doll or opening a door, so we constructed a shelf and screwed it to the wall beside the cabinet, where it is relatively inconspicuous. The shelf, which has retaining side pieces, like inverted brackets, is finished to match the woodwork of the room.—J. F. H.



You Can Build This Ideal Workbench—Yourself

THE pleasure of working with tools at home is greatly increased if you have a strong substantial bench with a good vise. One that also has drawers and tool cabinets is a constant incentive to keep tools in order and gave them the care and attention they deserve.

A blueprint of the Home Workbench illustrated, with full size details and bill of materials may be obtained by sending 25 cents to—

POPULAR SCIENCE MONTHLY
250 FOURTH AVENUE NEW YORK

Sir Arthur Keith Says Darwin Was Right

(Continued from page 30)

article, you will observe in the latter a striking advance along the road of intelligence. Here, you will agree, is a fine specimen of manhood—a face that is striking if not handsome, with high forehead, strong jaw and chin. The low ridged brow and other brute features of his predecessors have given place to the marks of intelligence and creative power. That he actually was such a man is evidenced by the flint implements he left behind him and by the skilful paintings and sculpture he left on the walls of his caves.

Such is the chronological line of fossil men who bear witness for evolution. Yet, we are warned, while the evidence they present is generally accepted by science, they by no means represent a direct line of ancestry linking men and apes.

MOREOVER, in the chronological succession there remain enormous gaps to be filled in before the evidence of man's anthropoid ancestry is completed. And the greatest gap lies between the highest kind of anthropoid and the lowest type of man yet found the Java Ape Man.

It may be that searchers among the rocks will eventually find this forefather in a still more remote past than that of the Java Man in the Miocene period, before the Ice Age, more than a million years ago, perhaps several million.

Back still farther, in Eocene time, some fifty million years or more ago, lived a strange little creature which, evolutionists believe, was the true originator of the family tree from which both man and the great anthropoids sprang. This was the tree shrew thought to link the insect eating mammals and the first primates. The tree shrew still exists in the East Indies, so little changed from its remote ancestors that it has been called "a living fossil." Later on, and representing the same transition, came the Notharctus, an early fossil ancestor of the lemur. The oldest known anthropoid ape, called Propliopithecus, is believed to have lived some 35,000,000 years ago. No larger than a small ring-tailed monkey, it bears out the evolutionary theory that small anthropoids were the forerunners of the great apes and man.

"Our inquiries are but begun," declared Keith in summarizing the evidence. "There is so much we do not yet understand. Will the day ever come when we can explain why the brain of man has made such great progress while that of his cousin, the gorilla, has fallen so far behind? Can we explain why inherited ability falls to one family and not to another or why, in the matter of cerebral endowment one race of mankind has fared so much better than another?

The answers to these and other mysteries of life may be found, he suggests, in the discovery of the life processes and influences which have shaped the evolutionary histories of man and ape.

IN RECENT years much has been learned about the action of the glands and their power to effect startling changes in the human body—changes sometimes as great as the differences between one race and another. Still other discoveries have revealed how the active cells of the body, working at their tasks, are coördinated by microscopic chemical messengers, the hormones, and dispatched through the blood stream from one department of the body to another. From which Keith concludes:

"With such sources of knowledge being ever extended and others of great importance, such as the study of heredity, we are justified in the hope that man will be able in due time not only to write his own history but to explain how and why events took the course they did.

How to Get the Most Out of Your Radio Investment

The Popular Science Institute has prepared a booklet that gives definite and helpful advice in buying, installing and operating a radio outfit. This 36-page radio booklet can be obtained for 25 cents from the Popular Science Institute, 353 Fourth Ave., New York City.

Answers to Sam Loyd Puzzles on Page 66

Alphabetical Arithmetic

The key word is DISCREPANT. Number the letters consecutively, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 0, and substitute their values for the letters in the sum, when it will be seen that the translation is as follows:

52
70
16
93
48

279

Finding a Hidden Science

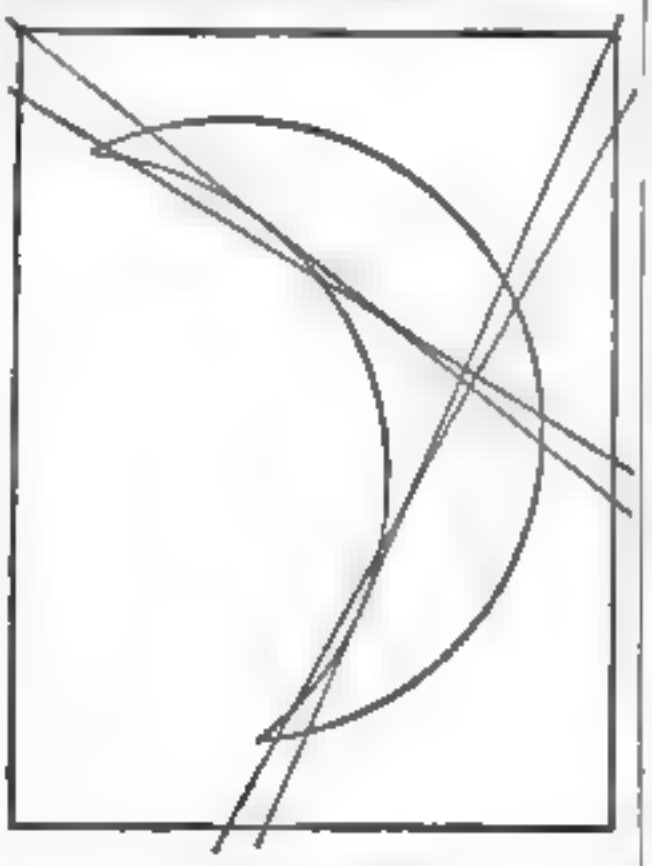
Words set down: Pitch, emigrate, strife, pantry.
Words struck out: Pit, grate, rife, pant.
Remaining word: CHEMISTRY.

Kindergarten Finance

Kitty must have had seven cents and her brother Harry five cents.

Dissecting the Moon

Four straight lines across the oblong can be made as shown in this diagram to produce fifteen segments of the crescent

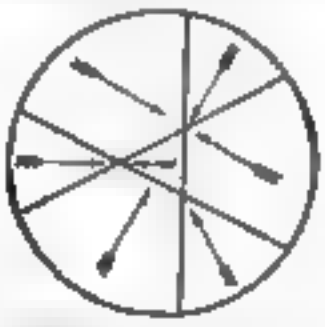


A Roman Mob

There were 91 men in that Roman mob. The stage manager's 90 supernumeraries that were "behind him" likewise were "ahead of him," since they traveled in a circle. Four fifths of 90, which is 18, added to one quarter of 90, which is 3, equals 91, the total number including the stage manager.

A Puzzling Crisscross

The diagram illustrates a three-line construction to separately pen the seven arrows.



Aviation Needs 10,000 Young Men

(Continued from page 44)

translated into audible signals which the flyer can pick up. That is a fertile field for study by electrical engineers.

"There are opportunities for civil engineers who know something of aviation and its problems, in laying out and building airports. There are only thirty-one completely equipped airports in America, there will be a need for several hundred in five years, and to build, equip and operate these airports is going to require the services of thousands of men.

"The biggest present need and the widest opportunity today is in getting business for the air transport lines already in operation and being organized," Frank Tichenor, editor of Aero Digest, told me.

THE newspapers have given columns of space to the experiment of the Royal Typewriter Company in delivering typewriters to customers by airplane. The novelty of such things will wear off, and the papers will cease to regard them as news. Then the young men with ideas about advertising and knowledge of aviation will have their chance.

It isn't easy to get passengers for airplanes, at least in the East. The air passenger service between New York and Boston was discontinued early in August, partly because men are afraid to risk their lives, not realizing that air travel is immensely safer than it used to be and getting safer all the time.

That is quite human and natural. The first Cornelius Vanderbilt, who later became the railroad king of America, refused to ride on a railroad train for more than twenty years after having been hurt in an accident on the first railroad built in the United States. Now twenty-five cents a day will buy a $5,000 accident insurance policy for railroad travelers, so safe have railroads become. The same thing will happen in respect to air travel. Half a dozen insurance companies are now offering air policies, some at very low rates. I can see opportunities for a great many enterprising young men, selling air insurance, on commodities as well as on lives.

Airplane mechanics are scarce, and the demand is growing. The Department of Commerce has ruled that none but licensed mechanics may repair or overhaul a licensed plane.

"An engine mechanic," says the Government manual of Air Commerce Regulations, "will be licensed upon passing an examination showing that he has sufficient knowledge of internal combustion engines, electricity and power plant of airplane types, and can properly inspect, repair, and overhaul airplane engines." And an airplane mechanic must pass an examination proving he is qualified "in plane structure, rigging, and control, and can properly inspect, repair, and overhaul airplane structures."

I WATCHED a young man at one of the flying fields tinkering with an airplane engine, a few weeks ago. "Have you got your Government license yet?" I asked him.

"Sure," he grinned, displaying his license card. "Why, I was just naturally handy with tools, and crazy about flying, so I came down here to learn to fly. My money gave out and I had to go to work. They found a place for me at $6 a week helping at all sorts of odd jobs. That was three years ago. Now I'm doing the fine work on the best engines. I used to work all day and study engine design all night. Some day I'm going to try out an engine of my own. I'm working on the patterns now."

"But how do you learn to fly, and what opportunities are there for the flying man who simply can't stay on the ground?"

Anybody can learn to fly. You can't become a military aviator (Continued on page 145)

Make More Money

Read the Money Making Opportunities on pages 146 to 174 of this issue.

Aviation Needs 10,000 Young Men

(Continued from page 142)

unless you are a practically perfect physical specimen. You can't get a first class Government license as a civilian airman if there is anything wrong with your heart, lungs, kidneys, digestive apparatus, throat, nose, ear or eyes. But you can learn to fly an airplane if you are able to drive an automobile.

A twelve-year-old boy, Frank Reppingille, in Detroit, has made solo flights. Farnam Parker, fourteen, of Anderson, Indiana, holds a pilot's license from the Federation Aeronautique Internationale, which was the only source of pilot's licenses in America until the United States Government began to issue them at the beginning of this year. The Government's minimum age for granting a license is sixteen, and there is no maximum. J. W. Meister, who flew from California to New York not long ago, is more than sixty. Captain H. I. Willoughby of Newport is still flying his own plane for the sport of it, at sixty-eight. Anybody can learn to fly.

THE best teacher of all is Uncle Sam, but since it costs the Government about $3,000 a head to train aviators, the Army, Navy and Marine Corps are rather particular about the sort of material they accept to start on. Even so, three quarters of those who start never become sufficiently expert to qualify for military service. But the Government does not insist upon the graduates of Kelly Field remaining in the service. They can go into civil aviation, and so become part of the Army's second line of air defense. And when a pilot has finished his year's course—half a year at either Brooks Field, San Antonio, or March Field, Riverside, Calif., and the rest at Kelly Field—he knows how to fly anything that can fly.

To get a chance to learn at Uncle Sam's expense the candidate must be unmarried, between the ages of twenty and twenty-seven, practically perfect physically, and with two years of college or its equivalent behind him. The men who today are holding the best jobs in commercial aviation, as air mail pilots, air surveyors, heading exploring expeditions, are almost without exception graduates of Kelly Field or of the other war-time training fields.

There are three other ways of learning to fly: hiring or persuading some expert flyer who has his own plane to teach you, joining a flying club, and entering one of the aviation schools, of which there are possibly a hundred in different parts of the country.

The flying club is a revival of the earliest of all methods of learning to fly. The very first airplane ever sold by its maker was bought by the Aero Club of New York from Glenn Curtiss in 1909, and with it many who later became famous in aviation learned to fly at Mineola. To start a flying club a number of would-be aviators combine to buy a plane for anywhere from $750 to $2,000 or more, engage the whole or part time services of a pilot as instructor, and take their turns at lessons.

THE vast majority of those who are now beginning to qualify for careers in commercial aviation are students in the regular schools of flying. I recently visited one of the oldest, which has graduated more than 500 flyers, without a single accident to a student.

"We give them ten hours in the air and a complete course in the elements of plane construction and repair, for $300," said the chief instructor, who himself flew in the war and taught many Army men to fly.

"We don't set up any rigid physical standards," he went on, "but we watch them carefully, and if a student doesn't show that he has the makings of an airman in him we give him his money back and wish him luck at something else."

(Continued on page 144)

Aviation Needs 10,000 Young Men

(Continued from page 143)

The course here takes from four to six weeks. The ten hours in the air is given in broken doses, of twenty minutes each, so that the student actually makes thirty flights.

Training is given in the old-fashioned "Jennies," the Curtiss JN4D's on which probably two thirds of our war flyers got their first training. These are small biplanes, equipped with ninety-horsepower engines, and having two cockpits, each provided with controls.

The instructor sits in the forward cockpit, the student in the after one.

"Keep your feet on the rudder bar and your hand on the control stick, but I'll do the steering," says the instructor. "Let your hands and feet be guided by the controls, instead of trying to guide them, and see what the ship does when I move either of them. And don't try to talk to me while we're in the air, because I can't hear you. Keep your safety belt fastened and don't get rattled. I'll bring you back all right."

AFTER a few flights with the instructor alone in control, he gradually lets the student guide the craft in the air, often without letting him know that he is doing it.

When the student has finished his course at one of the private aviation schools, he still has a lot of flying experience to gain before he can get a Government license as air pilot. And if he is going to make the flying end his part of the aviation game, he must have a pilot's license—an industrial, limited commercial or transport license.

It takes fifty hours of solo flying, that is, flying in complete command and control of the plane, to qualify for an industrial or limited commercial license; 300 hours for a transport pilot. Only transport pilots are allowed to carry passengers or mail, except that the holder of a limited commercial license may take up passengers for short flights over a limited area specified in his license. Industrial pilots may carry express matter but not passengers or mail, and private pilots may not carry either passengers or property for hire. A new form of private license, known as "student's license," has lately been established by the Department of Commerce, to let any actual flying student use a licensed plane while learning. The limited commercial license is calculated to enable the student, after he has got in fifty hours of solo flying, to make a living while getting in the remaining 150 hours necessary to qualify him for the transport license, the highest grade.

But to get in that first fifty hours of solo flying, the student must exercise some ingenuity or spend a good deal of money.

"WE RENT planes for solo flying, to our graduates, for $15 an hour," said the head of a school. "Some of them work out that cost, or part of it, in various jobs around the field. Some buy cheap planes for practice. Those who can otherwise qualify for the Air Reserve, either as graduates of the Reserve Officers Training Corps or as having had two years of college, can get some help from the Government in this part of their work, being permitted, after acceptance and enrollment in the Air Reserve, to use Government planes for a limited number of hours a month."

There are correspondence schools teaching the theoretical part of aviation—some of them quite thoroughly—and some have arrangements with practical flying schools whereby their students get a reduction in rates for that part of their instruction. But in general it costs from $1,000 upward, and takes the best part of a year of elapsed time.

There will be more than ten thousand opportunities for young men in aviation before long, but the "lucky" ones who will seize them will be the wise ones who begin to qualify now.

"Can he really play?" a girl whispered. "Heavens, no!" Arthur exclaimed. "He never played a note in his life."

They Laughed When I Sat Down At the Piano But When I Started to Play!—

ARTHUR had just played "The Rosary." The room rang with applause. I decided that this would be a dramatic moment for me to make my debut. To the amazement of all my friends I strode confidently over to the piano and sat down.

"Jack is up to his old tricks" somebody chuckled. The crowd laughed. They were all certain that I couldn't play a single note.

"Can he really play?" I heard a girl whisper to Arthur. "Heavens, no!" Arthur exclaimed. "He never played a note in all his life. But just watch him. This is going to be good."

I decided to make the most of the situation. With mock dignity I drew out a silk handkerchief and lightly dusted off the keys. Then I rose and gave the revolving piano stool a quarter of a turn, just as I had seen an imitator of Paderewski do in a vaudeville sketch.

"What do you think of his execution?" called a voice from the rear.

"We're in favor of it!" came back the answer, and the crowd rocked with laughter.

Then I Started to Play

Instantly a tense silence fell on the guests. The laughter died on their lips as if by magic. I played through the first bars of Liszt's immortal Liebesträume. I heard gasps of amazement. My friends sat breathless—spellbound!

I played on and as I played I forgot the people around me. I forgot the hour, the place, the breathless listeners. The little world I lived in seemed to fade—seemed to grow dim—unreal. Only the music was real. Only the music and the visions it brought me. Visions as beautiful and as changing as the wind-blown clouds and drifting moonlight, that long ago inspired the master composer. It seemed as if the master musician himself were speaking to me—speaking through the medium of music—not in words but in chords. Not in sentences but in exquisite melodies.

A Complete Triumph!

As the last notes of the Liebesträume died away, the room resounded with a sudden roar of applause. I found myself surrounded by excited faces. How my friends carried on! Men shook my hand—wildly congratulated me—pounded me on the back in their enthusiasm! Everybody was exclaiming with delight—plying me with rapid questions ... "Jack! Why didn't you tell us you could play like that?"

"Where *did* you learn?"—"How long have you studied?"—"Who was your teacher?"

"I have never even seen my teacher," I retorted. "And just a short while ago I couldn't play a note."

"Quit your kidding," laughed Arthur, himself an accomplished pianist. "You've been studying for years. I can tell."

"I have been studying only a short while," I insisted. "I decided to keep it a secret so that I could surprise all you folks."

Then I told them the whole story.

"Have you ever heard of the U. S. School of Music?" I asked. A few of my friends nodded. "That's a correspondence school, isn't it?" they exclaimed.

"Exactly," I replied. "They have a new simplified method that can teach you to play any instrument *by note* in just a few months."

How I Learned to Play Without a Teacher

And then I explained how for years I had longed to play the piano.

"It seems just a short while ago," I continued, "that I saw an interesting ad of the U. S. School of Music mentioning a new method of learning to play which only cost a few cents a day! The ad told how a woman had mastered the piano in her spare time at home—and *without a teacher!* Best of all, the wonderful new method she used required no laborious scales—no heartless exercises—no tiresome practising. It sounded so convincing that I filled out the coupon requesting the Free Demonstration Lesson.

"The free book arrived promptly and I started in that very night to study the Demonstration Lesson. I was amazed to see how easy it was to play this new way. Then I sent for the course.

"When the course arrived I found it was just as the ad said—as easy as A. B. C.! And as the lessons continued they got easier and easier. Before I knew it I was playing all the pieces I liked best. Nothing stopped me. I could play ballads or classical numbers or jazz, all with equal ease. And I never did have any special talent for music."

* * * *

Play Any Instrument

You too can now learn to play your favorite instrument—be an accomplished musician right at home in your spare time. You can go right ahead with this simple new method which has already shown almost half a million people how to play their favorite instruments by note. Forget that old-fashioned idea that you need special talent. Just read the list of instruments in the panel, decide which one you want to play and the U. S. School will do the rest. And bear in mind no matter which instrument you choose, the cost in each case is the same—just a few cents a day. No matter whether you are a mere beginner or already a good performer you will be interested in learning about this new and wonderful method.

Send for Our Free Booklet and Demonstration Lesson

Thousands of successful students never dreamed they possessed musical ability until it was revealed to them by a remarkable "Musical Ability Test" which we send entirely without cost with our interesting free booklet.

If you are in earnest about wanting to play your favorite instrument—if you really want to add happiness and increase your popularity—send at once for the free booklet and Demonstration Lesson. No cost—no obligation. Sign and send the convenient coupon now. Instruments supplied when needed, cash or credit. **U. S. School of Music, 812 Brunswick Bldg., New York City.**

Pick Your Instrument

Piano	Harmony and Composition
Organ	Sight Singing
Violin	Ukulele
Drums and Traps	Guitar
Mandolin	Hawaiian Steel Guitar
Clarinet	Harp
Flute	Cornet
Saxophone	Piccolo
'Cello	Trombone

Voice and Speech Culture
Automatic Finger Control
Piano Accordion
Banjo (5-String, Plectrum or Tenor)

U. S. School of Music,
812 Brunswick Bldg., New York City.

Please send me your free book, Music Lessons in Your Own Home, with introduction by Dr. Frank Crane, Demonstration Lesson and particulars of your offer. I am interested in the following course:

Have you above instrument?

Name .....
(Please write plainly)

Address .....

City ..... State .....

Money Making Opportunities for Readers of Popular Science Monthly

Advertising Services

Authors, Song Poem Writers, Manuscripts

Automobile Accessories

VULCANIZING Auto Tires is a Paying Business. We have Plants cost you from $50 up. Catalog free. 112 East 11th, Los Angeles, Calif.

Aviation

Bending Machines

Blue Prints

Boats and Launches

Rates 30 Cents a Word. A 10% discount is allowed on all contracts for six consecutive insertions. Advertisements intended for the February, 1928, issue should be received by December 5th.

Boats and Launches

Books

Branch Office Services

Business Opportunities

NEW System Mail Order, big profits, instructions free. Evans & King Co., Wilmington, Del.

Business Opportunities

Capital or Manufacturer Wanted

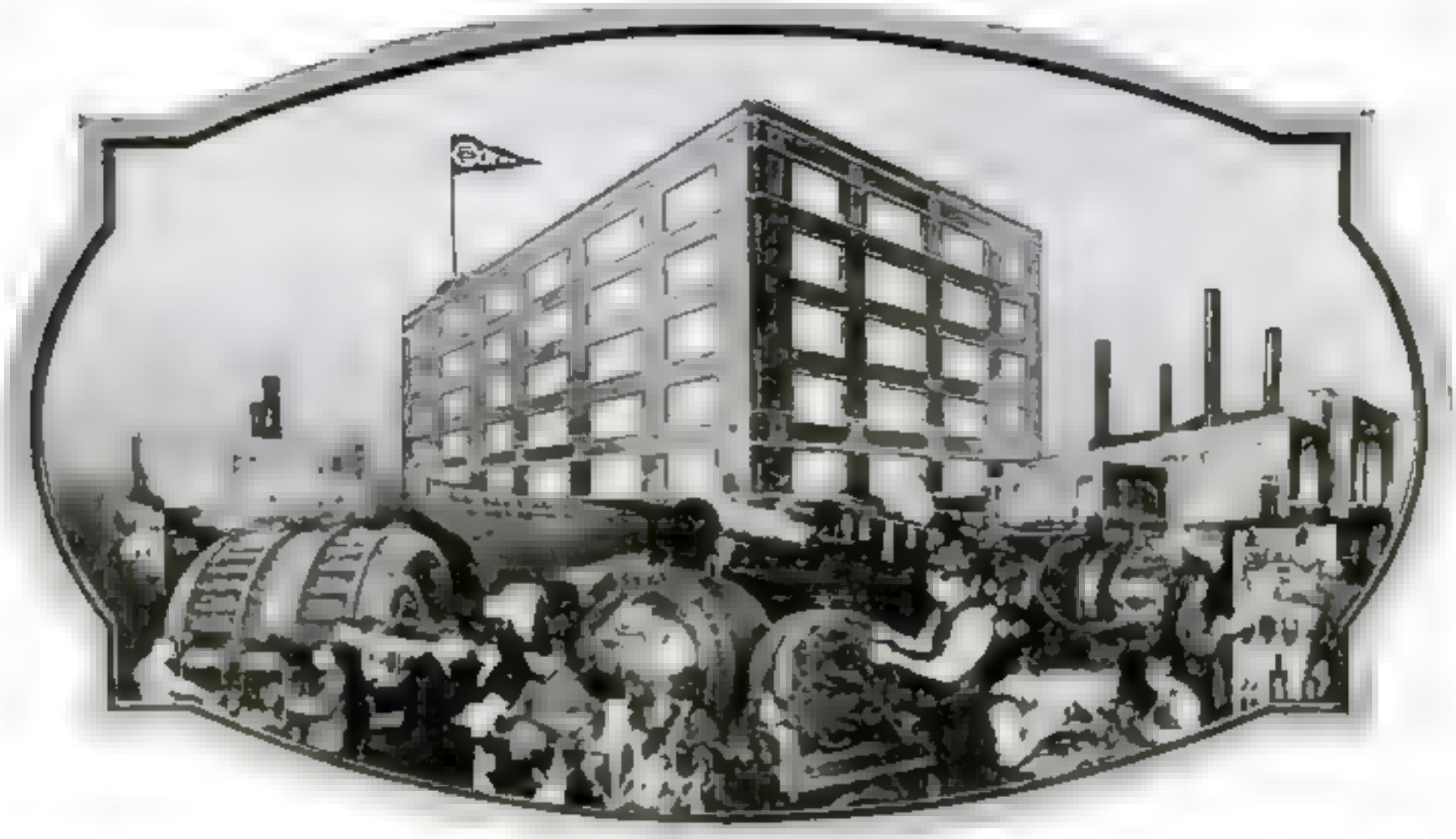
Chalk Talks

LAUGH producing program, $1.00. Catalog free. Cartoonist Hollis, Oshkosh, Wisconsin.

Chemistry

Dogs, Birds, Fish

Education and Instruction



Get into ELECTRICITY

—Learn in 90 Days— WITHOUT BOOKS OR LESSONS—

Don't spend your life waiting for $5 raises in a dull, hopeless job. Now . . . and forever . . . say good-bye to 25 and 35 dollars a week. Let me show you how to qualify for jobs leading to salaries of $50, $60 and up, a week, in Electricity—NOT by correspondence, but by an amazing way to teach, that makes you a practical expert in 90 days! Getting into Electricity is far easier than you imagine! Act now, today!

NEW—Quick Amazingly Easy Method!

Lack of experience—age or advanced education bars no one. I don't care if you are 16 years old or 40. It makes no difference. Don't let lack of money stop you. Most men at Coyne have no more money than you have.

Earn While Learning

If you should need part time work, I'll assist you in getting it. Then, in 12 brief weeks in the great roaring shops of Coyne, I'll train you as you never dreamed you could be trained.

No Books—No Printed Lessons

You work on real live electrical machinery, building real batteries, winding real armatures, operating real motors, dynamos and generators, wiring real houses, etc., etc., here in this world famous parent school, with its hundreds of thousands of dollars worth of new up-to-date electrical equipment.

Jobs—Pay—Future

Don't worry about a job. Coyne training settles the job question for life. Clyde F. Hart got a position as electrician with the the Great Western Railroad at over $100.00 a week. That's not unusual. We can point to

Prepare For Jobs Like These

Armature Expert
Auto Electrician
Inventor
Maintenance Engineer
Service Station
Radio Expert

Coyne men making up to $800.00 a month. Easy to get jobs leading to $60 a week and up, while starting your own electrical business puts you in a position to become independent.

Get the Facts

Send now for my big 56-page book containing 150 photographs, telling the whole Coyne story. It tells you how many earn expenses while training and all about our lifetime employment service. We are now in our new $2,000,000 school—the finest school in the world devoted to the exclusive training in Electricity.

Coyne is your one great chance to get into electricity. Every obstacle is removed. This school is 28 years old—Coyne training is tested, proven beyond all doubt—endorsed by many large electrical concerns. You can find out everything absolutely free. Simply mail the coupon and let me send you the big, free Coyne book.

My Course Includes Training in **Aeroplane Electricity**

Not a Correspondence School

COYNE Electrical SCHOOL

H. C. LEWIS, Pres., Dept. 27-75—Established 1899

500 So. Paulina Street, Chicago

Send for Free Book!

Mr. H. C. Lewis, Pres.
COYNE ELECTRICAL SCHOOL, Dept. 27-75
500 So. Paulina Street, Chicago, Ill.

Dear Mr. Lewis:—Without obligation send me your big free catalog and all details of Free Employment Service, Radio and Automotive Courses, and how I can earn while learning. It is understood I will not be bothered by any salesman.

Name_____

Address_____

City_____ State_____

For Electricians and Helpers

ELECTRICIANS and Helpers send dollar for Questions and Answers. Learn [illegible] more pay. Hinman 2034 W. Hancock, Detroit, Mich.

THE Electrician's Wiring Manual, by F. F. Sengstock, E. E. Contains all the information needed for the proper installation of lighting and power systems in houses and other buildings. It completely covers inside electrical wiring and construction in accordance with the National Electric Code. Pocket size, flexible binding. 448 pp. Price $2.50. Popular Science Monthly, 350 Fourth Ave., New York City.

For Inventors

UNPATENTED Ideas Can be sold. I tell you how and help you make the sale. Free particulars. (Copyrighted.) Write W. T. Greene, 804 Jenifer Building, Washington, D. C.

INVENTIONS Commercialized. Patented or unpatented. Write Adam Fisher Mfg. Co., 183 Enright, St. Louis, Mo.

I AM in touch with hundreds of moneyed men and manufacturers who wish to buy good inventions. Hartley, 38 [illegible], Bangor, Maine.

INVENTORS' Universal Educator: contains 900 mechanical movements; 50 perpetual motions. Tells how to obtain and sell patents. Suggests new ideas. Explains how to select your attorney and avoid patent sharks. Special Price, $1.00 postpaid. Albert E. Dieterich, 602 Ouray Bldg., Washington, D. C.

INVENTION and Advisory service. Experienced patent and marketing assistance. Correspondence invited. [illegible] J. Williams, Patent Engineer, American Bank Bldg., Oakland, Calif.

INVENTORS wishing to commercialize their patents safely should write [illegible] Inventors Service Bureau, Box [illegible], Racine, Wisconsin, for advice.

ALL Advertisers should ask for, without the [illegible] and facts on Money Making. Write today for the "Quick Action Advertising Rate Folder" which contains information of value to you. If you are anxious to quick profit returns do it now. Address your inquiry to Manager, Classified Advertising, Popular Science Monthly, 350 Fourth Ave., New York.

For Men and Women

DETECTIVES. Work home or travel. Experience unnecessary. Particulars free. Write, George Wagner, 2190-P Broadway, N. Y.

Formulas

BE FREE. With Your own Products. Make them yourself. Formulas, Processes, Trade-Secrets. All lines. Catalog, circulars free. C. Thaxly Co., Washington, D. C.

DON'T Buy Formulas till you've read my Valuable "Free Formula" Literature for producing Guaranteed Money Making Specialties in all lines. Mailed free. Address Miller, Manufacturer's Chemist, Tampa, Florida.

For Sale

FOR Sale. Patent Improved Floor Sifter outright or Royalty Basis. [illegible] Nakagawa, Lanana, Alaska.

For the Home

HOT water on tap. $5. Make your own Automatic. Write John Kirkby, San Luis Obispo, Calif.

[illegible] FEATHER clock works, $2.00. Build your own case. Instructions free. Make good profits selling your friends. Clock works with chimes for old or new cases. Write for full particulars, Clark [illegible], Nittstown, Penn.

TO THE man who likes to work with tools, Popular Science Monthly offers the opportunity to purchase blueprints giving the details of the construction of useful articles for the home. The following are a few of the blueprints available: No. 1 Sewing Table, No. 5 Kitchen Cabinet, No. 14 Tea Wagon, No. 18 Workshop Bench, No. 7 Chests and Mahogany Chest, No. 42 Four Tube Radio Receiver, 44 and 45, Model Pirate Ship, 46 and 47 Spanish Galleon, 48, Model Sailing Yacht. Send 25c for each blueprint that you wish to Popular Science Monthly, 350 Fourth Avenue, New York, N. Y.

[illegible] Cellar, [illegible] Brightman [illegible], Chicago.

Help Wanted

EARN $25 weekly, spare time, writing for newspapers, magazines. Experience unnecessary. Details free. Press Syndicate, 971, St. Louis, Mo.

STEAMSHIP positions—Europe, Orient. Good pay. Experience unnecessary. List of positions free. Box 122-P, Mount Vernon, N. Y.

SILVERING Mirrors, French plate, easily learned, immense profits. Plans free. Wear Mirror Works, Excelsior Springs, Mo.

[illegible] get Forest Ranger job; $125-$200 mo. and home furnished; permanent; hunt, fish, trap. For details, write Norton, 344 Temple Court, Denver, Colo.

WANTED—Every foreman or mechanic or clerk in every factory in the United States to act as subscription representative for the most popular magazine in the world. Address Manager of Representatives, Popular Science Monthly, 350 Fourth Ave., New York.

BE A DETECTIVE. [illegible] credentials and [illegible] membership $2. Money back if not satisfied. [illegible] Secret Service System, Box 818, Waukegan, Illinois.

COUNTY Representatives for Credit & Rating [illegible] Liberal Drawing Account. Western Credit Index, 203 Lankershim Building, Los Angeles.

MEN. Get Forest Ranger or Railway Mail positions, $125-$225 monthly, steady, experience unnecessary. For details write F. Bradford, 21 North 52nd St., Philadelphia, Pa.

MEN with cars to take orders and deliver sanitary brushes guaranteed salary and commission. Full details on request. North Ridge Brush Co., Freeport, Ill.

Help Wanted Instruction

DETECTIVES Earn Big Money. Excellent opportunity. Travel. Fascinating work. Experience unnecessary. Write, George Wagner, 2190-P Broadway, N. Y.

MEN wanting outdoor work, qualify for forest ranger position. Start $125 month; cabin and vacation; patrol the forests; protect the game; give tourists information. Write Mokane, Dept. M-29, Denver, Colo.

FIREMEN, Brakemen, Baggagemen, white or colored; sleeping car, train porters (colored), $150-$250 month. Experience unnecessary. 836 Railway Bureau, East St. Louis, Ill.

RECEIVERS prepared for positions in Bermuda and Florida hotels. Fares paid. Write Hotel Institute, Drawer 1598, Boston.

MEN, Women, 18 up. U. S. Government Jobs. $105 to $250 month. Steady pleasant work. Paid vacation. Short hours. Experience unnecessary. Common education sufficient. 32-page book free. Write today, sure for list positions and full particulars. Franklin Institute, Dept. [illegible], Rochester, N. Y.

How to Entertain

PLAYS, musical comedies and revues, minstrel music, blackface skits, vaudeville acts, monologs, dialogs, recitations, entertainments, musical readings, stage handbooks, make-up goods. Big catalog free. T. S. Denison & Co., 623 So. Wabash, Dept. 28, Chicago.

PUZZLE. The best cross block puzzle made. [illegible] combinations. Complete set one dollar. Postpaid. Puzzle, Box 971, Astoria, Oregon.

Incorporations

DELAWARE Incorporation. Charters. Fees small. Forms. Rae G. Geyer, 911 Market Street, Wilmington, Delaware.

Indian Goods

[illegible] Indian arrowheads from Arkansas [illegible] paid. [illegible]

Inventions for Sale

AUTOMATIC Brakes a straight [illegible] proposition. Charles [illegible], [illegible], Idaho.

Inventions Wanted

INVENTIONS commercialized. Patented or unpatented. Write Adam Fisher Mfg. Co., 183 Enright, St. Louis, Mo.

WE WILL buy suitable inventions. Write Martin Laboratories, Gap, Pennsylvania.

Laboratory and Chemical Services

YOUR chemical problem solved and working formula or process furnished for $5.00. Write me. W. Stedman Richards, Industrial Chemist, Box 2402, Boston, Mass.

IMPORTANT to advertisers! Are you deriving profit from your advertising? Write today for a copy of the "Quick Action Advertising Rate Folder" showing "How You Can Use Popular Science Monthly Profitably." Address your inquiry to Manager, Classified Advertising, Popular Science Monthly, 350 Fourth Ave., New York.

Magic Tricks

NEW 1937 "Fun-Magic-Mystery" now ready. 50 pages profusely illustrated. Over 700 tricks. Illusions, jokes, puzzles, books. European Novelties at reduced prices. Postpaid, 10c. Lyle Douglas, Station A-6, Dallas, Texas.

MAGIC Trick Cards That are Absolutely Guaranteed. Best Bicycles and Steamboats. Free samples. [illegible] Blankenship, Adrian, W. Va.

BE A magician give shows, earn money. Catalogue 25c. Oaks Magical Co., Dept. 431, Oshkosh, Wis.

Manufacturing

WIRE. Steel, Aluminum, Copper and Brass. Wire goods manufactured to order. [illegible] Manufacturing Co., 328 N. Western Ave., Chicago, Illinois.

Miscellaneous

FORMS to cast Lead Soldiers, Indians, Marines, Trappers, Animals, 151 kinds. Send 10c for illustrated catalogue. H. C. Schiercke, [illegible] Brooklyn, N. Y.

NEW ADVERTISERS. Ask today for a copy of the "Quick Action Advertising Rate Folder." It contains some easily important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." Would like to know how [illegible]. Address your inquiry to Manager, Classified Advertising, Popular Science Monthly, 350 Fourth Avenue, New York.

[illegible] Remover formula $1.00. Supply Catalogue. Watters, 964 Pullman, Detroit.

Models and Model Supplies

SPECIAL Machinery or parts free. Tools, Metal Specialties, Model steering, [illegible] stock gears and Model Supplies. Send 10c for Catalogue. The Pierce Model Works, [illegible] Park, Ill.

[illegible] Model Aircraft [illegible] and tubing. Fred [illegible] 44th St., New York.

MODEL steam engines and boilers. Nut and boiler fittings. Send 10c stamp for catalog, [illegible] Model Machine Shop, [illegible] New Jersey.

SHIP Models, complete parts and blueprints for Three Masted Chinese Junk, 60c postpaid. Chase-Craft, Framingham, Mass.

LET our experience be your guide. Models that are models. Tools and equipment for economic manufacturing. Patterns of all types, manufacturing in all branches. Satisfaction guaranteed. United Machinery Company, Engineering Dept., Cincinnati, U. S. A.

Models and Model Supplies

SHIP Model Fittings, Steering Wheels, Capstans, Anchors, Propellers, etc. Send stamp for booklet. A. J. Fisher, 1002 Etowah Ave., Royal Oak, Mich.

EVERYTHING for Ship Models. Catalog, dime. Boucher, [illegible], Portsmouth, Va.

IMPORTANT to advertisers! Are you deriving profit from your advertising? Write today for a copy of the "Quick Action Advertising Rate Folder" showing "How You Can Use Popular Science Monthly Profitably." Address your inquiry to Manager, Classified Advertising, Popular Science Monthly, 350 Fourth Ave., New York.

Motorcycles

MOTORCYCLE bargains. Used, rebuilt, guaranteed. Shipped on approval. Catalog free. Floyd Clymer, 817 Broadway, Denver, Colo.

Moving Picture Business

BE A Movie Exhibitor!—Big Opportunity. Only Moderate Capital Required. Complete equipment at Reasonable Low Prices. Write for the Moving Picture Co., 844 South Michigan Ave., Chicago, Ill.

Music and Musical Instruments

SAXOPHONISTS, Clarinetists, Cornetists, Trombonists, etc. Free Pointers. Virtuoso Music School, 38, Buffalo, N. Y.

[illegible] [illegible] for $1.00. For Amateur Teacher or Student. Catalog free. Fred Zeitz, P. O. B. 18, Sta. D, New York.

Novelties and Pictures

ART Pictures, Books and Novelties. Catalog 10c. Howard Sales Co., Dept. 8, 1188 Folsom St., San Francisco, Calif.

[illegible] novelties, books, magazines, foreign publications. Catalog free. Villaverde Co., Box 1329, Havana, Cuba.

IMPORTANT to advertisers! Are you deriving profit from your advertising? Write today for a copy of the "Quick Action Advertising Rate Folder" showing "How You Can Use Popular Science Monthly Profitably." Address your inquiry to Manager, Classified Advertising, Popular Science Monthly, 350 Fourth Ave., New York.

Office Devices

ADDRESSING machines, multigraphs, duplicators, folders, typewriters, sealers, dictating machines at about half original cost. Pruitt, [illegible], Chicago.

ALL Advertisers should not be without the [illegible] and facts on Money Making. Write today for the "Quick Action Advertising Rate Folder" which contains information of value to you. If you are anxious for quick profit returns, do it now! Address your inquiry to Manager, Classified Advertising, Popular Science Monthly, 350 Fourth Ave., New York.

Patent Attorneys

PATENTS—Time counts in applying for patents. Don't risk delay in protecting your ideas. Send sketch or model for instructions or write for FREE book, "How to Obtain a Patent" and "Record of Invention" form. No charge for information on how to proceed. Communications strictly confidential. Prompt, careful, efficient service. Clarence A. O'Brien, Registered Patent Attorney, Security Bank Building (directly across street from Patent Office), Washington, D. C. See page [illegible].

PATENTS. Booklet free. Highest references. Best results. Promptness assured. Watson E. Coleman, Patent Lawyer, 724 9th Street, Washington, D. C.

UNPATENTED Ideas can be sold. I tell you how and help you make the sale. Free particulars. (Copyrighted.) Write W. T. Greene, 811 Jenifer Building, Washington, D. C.

[illegible] spent annually for Ideas! Hundreds now wanted! Patent yours and profit! Write today for free book. Tells how to protect yourself, how to invent, ideas wanted, how we help you sell, etc. American Industries, Inc., [illegible] Bldg., Washington, D. C.

MONROE E. MILLER, Ouray Bldg., Washington, D. C. Patent Lawyer, Mechanical, Electrical Expert. Booklet and Priority Record blank gratis.

RICHARD B. OWEN, Patent Lawyer, Washington Loan & Trust Bldg., Washington, D. C. Booklet.

PATENT, trade-marks, copyrights. Reliable service by an experienced practitioner devoting personal attention to each case. Inquiries invited. References furnished. B. P. Fishburne, Patent Lawyer, 525-C McGill Building, Washington, D. C.

LANCASTER, ALLWINE, 232 Ouray Building, Washington, D. C. Originators of the form "Evidence of Conception." Before disclosing your invention to anyone send for blank form, to be signed and witnessed. Form and information folder free.

NEW ADVERTISERS. Ask today for a copy of the "Quick Action Advertising Rate Folder." It contains some real important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." Would like to know [illegible]. Address your inquiry to Manager, Classified Advertising, Popular Science Monthly, 350 Fourth Avenue, New York.

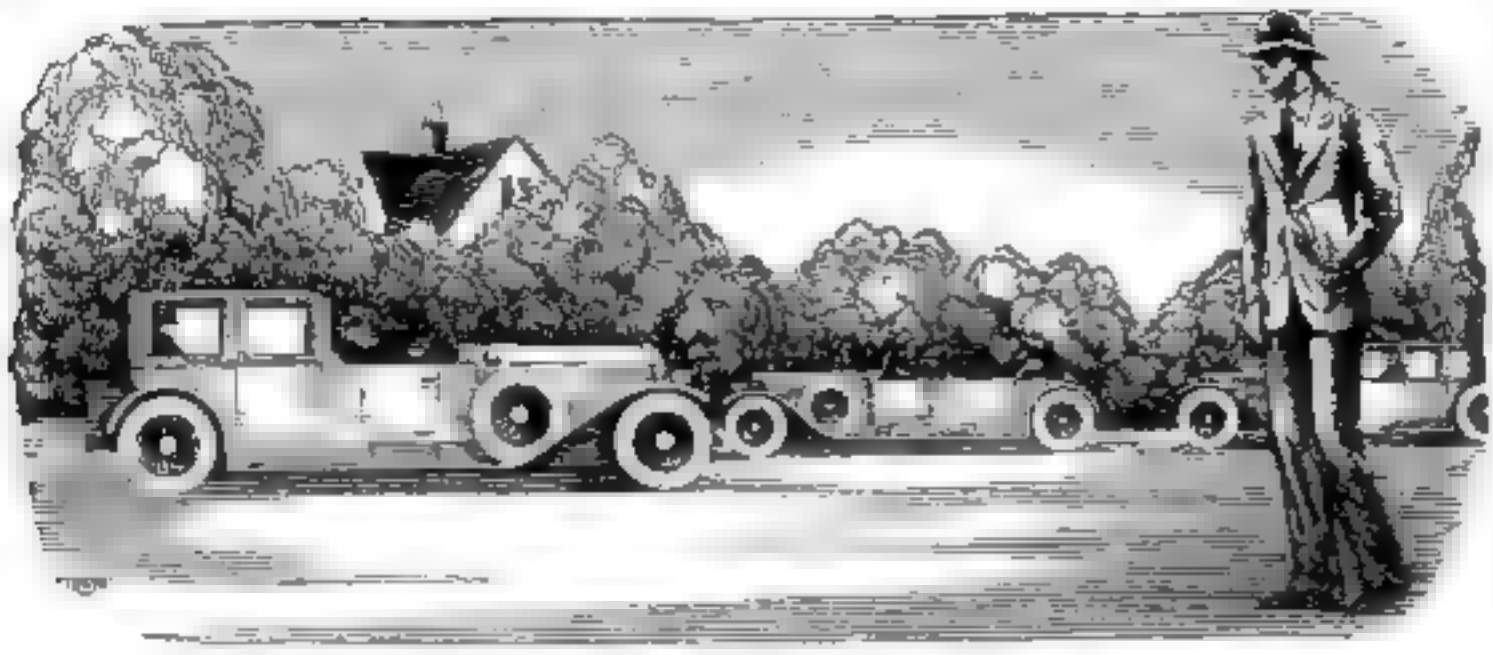
[illegible] valuable patent book sent free. Lester [illegible], New York.

PATENTS. Free advice promptly. [illegible] Patent Office [illegible]. Booklet. Albee, [illegible] Bldg., Washington.

ADAM E. FISHER, Registered Patent Attorney in business [illegible] years. References, personal attention and promptness assured. Dept. E, 183 Enright, St. Louis, Mo.

INVENTORS' Guide free on request; gives valuable information and advice for all who have original ideas or improvements. Frank L. Lederman, Registered Attorney and Engineer, Woolworth Bldg., [illegible] New York.

PATENTS secured. Low terms. Inventors Service Bureau, Box 1648, Washington.



Many times in the old days while I trudged home after work to save carfare, I used to gaze enviously at the shining cars gliding by me, the prosperous men and women with it. Little did I think that inside of a year I too, would have my own car, a decent bank account, the good things of life that make it worth living.

I Thought Success Was For Others

Believe It Or Not, Just Twelve Months Ago I Was Next Thing To "Down-and-Out"

TODAY I'm sole owner of the fastest-growing Radio store in town. And I'm on good terms with my banker, too—not like the old days only a year ago, when often I didn't have one dollar to knock against another in my pocket. My wife and I live in the snuggest little home you ever saw, right in one of the best neighborhoods. And to think that a year ago I used to dodge the landlady when she came to collect the rent for the little bedroom I called "home!"

It all seems like a dream now, as I look back over the past twelve short months, and think how discouraged I was then, at the "end of a blind alley." I thought I never had had a good chance in my life, and I thought I never would have one. But it was waking up that I needed, and here's the story of how I got it.

I WAS a clerk working at the usual miserable salary such jobs pay. Somehow I'd never found any way to get into a line where I could make good money.

Other fellows seemed to find opportunities. But—much as I wanted the good things that go with success and a decent income—all the really well-paid vacancies I ever heard of seemed to be out of my line, to call for some kind of knowledge I didn't have.

And I wanted to get married. A fine situation, wasn't it? Mary would have agreed to try it—but it wouldn't have been fair to her.

Mary had told me, "You can't get ahead where you are. Why don't you get into another line of work, somewhere that you can advance?"

"That's fine, Mary," I replied, "but what line? I've always got my eyes open for a better job, but I never seem to hear of a really good job that I can handle." Mary didn't seem to be satisfied with the answer but I didn't know what else to tell her.

It was on the way home that night that I stopped off in the neighborhood drug store, where I overheard a scrap of conversation about myself, a few burning words that were the cause of the turning point in my life!

With a hot flush of shame I turned and left the store, and walked rapidly home. So that was what my neighbors—the people who knew me best—really thought of me!

"Bargain counter shark—look how that suit fits," one fellow had said in a low voice. "Bet he hasn't got a dollar in those pockets." "Oh, it's just Lawless Anderson," said another. "He's got a wish-bone where his back-bone ought to be."

As I thought over the words in deep humiliation, a sudden thought made me catch my breath. Why had Mary been so dissatisfied with my answer that "I hadn't had a chance?" *Did Mary secretly think that too?* And after all, wasn't it *true* that I had a "wish-bone" where my back-bone ought to be? Wasn't that why I never had a "chance" to get ahead? It was true, only too true—and it had taken this cruel blow to my self-esteem to make me see it.

With a new determination I thumbed the pages of a magazine on the table, searching for an advertisement that I'd seen many times but passed up without thinking, an advertisement telling of big opportunities for trained men to succeed in the great new Radio field. With the advertisement was a coupon offering a big free book full of information. I sent the coupon in, and in a few days received a handsome 64-page book, printed in two colors, telling all about the opportunities in the Radio field and how a man can prepare quickly and easily at home to take advantage of these opportunities. I read the book carefully, and when I finished it I made my decision.

WHAT'S happened in the twelve months since that day, as I've already told you, seems almost like a dream to me now. For ten of those twelve months, *I've had a Radio business of my own!* At first, of course, I started it as a little proposition on the side, under the guidance of the National Radio Institute, the outfit that gave me my Radio training. It wasn't long before I was getting so much to do in the Radio line that I quit my measly little clerical job, and devoted my full time to my Radio business.

Since that time I've gone right on up, always under the watchful guidance of my friends at the National Radio Institute. They would have given me just as much help, too, if I had wanted to follow some other line of Radio besides building my own retail business—such as broadcasting, manufacturing, experimenting, sea operating, or any one of the score of lines they prepare you for. And to think that until that day I sent for their eye-opening book, I'd been wailing "I never had a chance!"

NOW I'm making real money. I drive a good looking car of my own. Mary and I don't own the house in full yet, but I've made a substantial down payment, and I'm not straining myself any to meet the installments.

Here's a real tip. You may not be as badly off as I was. But, think it over—are you satisfied? Are you making enough money, at work that you like? Would you sign a contract to stay where you are now for the next ten years, making the same money? If not, you'd better be *doing* something about it instead of drifting.

This new Radio game is a live-wire field of golden rewards. The work, in any of the 20 different lines of Radio, is fascinating, absorbing, well-paid. The National Radio Institute—oldest and largest Radio home-study school in the world—will train you interestingly in your own home to know Radio from A to Z and to increase your earnings in the Radio field.

Take another tip—No matter what your plans are, no matter how much or how little you know about Radio—clip the coupon below and look their free book over. It is filled with interesting facts, figures, and photos, and the information it will give you is worth a few minutes of anybody's time. You will place yourself under no obligation: the book is free, and is gladly sent to anyone who wants to know about Radio. Just address J. E. Smith, President, National Radio Institute, Dept. O-87, Washington, D. C.

J. E. Smith, President,
National Radio Institute,
Dept. P-87, Washington, D. C.

Dear Mr. Smith:

Please send me your 64-page free book, printed in two colors, giving full information about the opportunities in Radio and how I can learn quickly and easily at home to take advantage of them. I understand this request places me under no obligation, and that no salesman will call on me.

Name .....

Address .....

Town ..... State .....

Patent Attorneys

[illegible]

Patents for Sale

[illegible]

Photographs and Supplies

[illegible]

Photoplays Wanted

[illegible]

Printing and Engraving

[illegible]

Rubber

[illegible]

Real Estate Orchards Farm Lands

[illegible]

Salesmen and Agents Wanted

[illegible]

Salesmen and Agents Wanted

[illegible]

Salesmen and Agents Wanted

[illegible]

Stamps and Coins

STAMPS, 100 All different, 3 cents. Lists free. [illegible] Quaker Stamp Co., Toledo, Ohio.

STAMP Collectors: Phillips [illegible] Bulletin [illegible] offers over [illegible] special bargains, sets, packets, etc. each issue, free. Phillips, Box 1012, Hartford, Conn.

[illegible] Large Fall selling [illegible] sale free [illegible] William Hesslein, 101B Tremont Street, Boston, Mass.

[illegible] National Scholia, Box 756, Salt Lake [illegible]

[illegible] mixed foreign stamps [illegible]

[illegible] free [illegible] Toledo [illegible]

[illegible] bargain lists [illegible] Approvals for beginners. [illegible] Indiana.

[illegible] $0.50 [illegible] Street, Brooklyn.

[illegible] Military [illegible] Colorado Springs, Colorado.

[illegible]

Stories Wanted

[illegible]

Technical Schools

[illegible]

Telegraphy

[illegible]

Tree and Weed Killer

[illegible]

Typewriters and Supplies

[illegible]

Wanted

[illegible] Broadway, N. Y.

The Welder—Tailor of Steel

(Continued from page 58)

to accurate dimensions, making them almost as good as new.

By similar methods, railway shops throughout the country are practicing large savings in equipment. Worn car wheels are built up by welding, lengthening their life as much as twenty percent. Worn rails are salvaged in the same manner. Rails with battered ends are repaired and reclaimed by welding without even removing the rails. Another recent development is the fabrication of welded steel railroad ties from worn pieces of metal track. Recent tests of such ties in railroad yards at Albany, N. Y., have indicated that they are ten times as strong as ordinary wooden ties and cost about one third as much.

IN THE automobile industry welding is proving invaluable in the manufacture of such parts as rear axle housings, torque tubes, bodies and frame members. Wire wheels for some automobiles are made by welding, and it has even been applied to the manufacture of spark plugs.

Even in the building of ships welded construction is proving feasible. Only a few weeks ago the first all-welded oil tanker was completed in a boiler works at Providence, R. I., and now it is operating successfully. The vessel weighs seventy tons, and its tanks have a capacity of [illegible] gallons.

Manufacture of tanks and containers of all kinds furnace boilers, ice cream cans, refuse containers and the like—is being speeded by the welder's needle For this work two kinds of welding seam are necessary longitudinal and circular and both are welded by automatic machines The operator merely presses a button and the machine does the rest The first arc welded gas tank, with a capacity of 15,000 cubic feet, now supplies the town of Lexington, Mo. It was built in six weeks.

Many pipeline systems for water and gas recently have been made by welding The first one to be completely welded, and the longest of its type, was constructed last year for the city of Vallejo, Calif. It is twenty-two miles long and carries water from one reservoir to another. The pipes carry a pressure as high as 175 pounds per square inch.

Two gas lines, extending for 300 miles from West Virginia into Ohio, are formed of twenty-inch welded steel pipe. A similar gas line, soon to be built, will extend 450 miles from the Texas Panhandle to Kansas City, Mo. It will carry 100 million cubic feet of natural gas daily at a maximum pressure of 450 pounds to the square inch.

SINCE the success of any welding operation depends largely on the skill of the operator, the General Electric Company recently has established a welding school in connection with its Schenectady shops. Here the company trains not only its own welders, but men from other manufacturing concerns who desire to become experts in the new science. Here students have turned out welded cabinets, lockers, refuse cans, stools, ladders, wheelbarrows, portable tables, carts, ash trucks and other equipment.

In the research laboratories scientists are constantly improving welding methods. Two new processes of producing more ductile welds recently were announced by two General Electric experimenters, working independently. In both processes, air is excluded from the metal by means of a bath of hydrogen or other gas. The formation of oxides and nitrides in the weld metal in thus prevented and the fused metal is declared to be as strong and ductile as the original metal

These advances are opening still more fields for the application of metal stitching and are hastening the day when the nerve racking noise of the pounding riveter will vanish.

Whirling Wheels

(Continued from page 48)

Perfectly legitimate—if he can get away with it. But—well, he hasn't hung himself quite enough for me yet, and until he does—" he shrugged.

"My boy, I apologize!" It was Oliver H. Marston. "I've done a little bluffing in my day, but that—that was masterful! Masterful!"

"It does kind of balance up the account on a T-head motor, doesn't it?" laughed Gil. "Now let's go ahead with business."

Then it was that Gil made certain promises. There was no doubt that the financial situation was dark. But, Gil maintained, that situation was only temporary. Automobiles had come to stay. Thousands of people owned them, there were automobile clubs everywhere, banded together under the name of the Automobile Association of America, which was plugging for good roads and charting them, influencing the passage of sane laws, conducting runs. There were races and road events of all kinds, for professionals and amateurs. Glidden of Boston had inaugurated a yearly tour for amateurs, there were endurance and reliability runs galore. The public had the bug: a fact that was proved, if by nothing else, by all those mortgages. And they would continue to have it. So the thing to do was to weather this storm.

THERE was nothing to do but close the plant down completely. Men must be laid off who had never had an idle day since the new walls went up. "But we can meet a little pay roll with the money that Andy here is going to get in from the dealers, and with that we're going to get ready for some cutting of corners that have never been cut before.

"Do you realize what we've been doing?" continued Gil without expecting an answer. "I didn't until just a short time ago. Our selling price has been going up and up. Every year we've raised it instead of lowering it. Three thousand dollars this year—with top and windshield extra! The trouble with us has been that we haven't had to sell, people have bought. From now we're going to have to sell, more and more. Andy knows that, don't you Andy?"

"I sure do."

"So we've got to cut corners, more than we've ever cut before. How about it, Mac?"

"I'm hopin' so, Meester Herrick, but—" he looked doubtful, and Gil laughed.

"Mac here thinks I'm crazy, but then you've thought so before, haven't you, old-timer? And you always go across with me. What we're going to do is take the progressive assembly idea into the machine shop; we're going to machine progressively."

THAT was over their heads, so Gil explained. It was a case of starting the raw material—steel, cast iron, or whatnot, at one end of the shop and putting it through each successive machining process in order, so that when it was finished it would be "not more than two feet, maybe two inches, from the hand of the man who wants to put that unit on the car."

The thing that concerned Mac was that he would no longer be able to departmentalize his shop. There would be no lathe, no milling machine, no screw machine departments with responsible foremen. If it was necessary to put a lathe next to a screw machine, put it there; if a heating furnace had to be jammed up beside a milling machine, put it there; and when a man had done his job on the piece, he would drop it in a roller chute instead of a tote box, and it would roll by gravity to its next operation.

"No machine departments: parts departments, all of them. Well, suppose we had a map here that showed the rivers of the country. Trace one of (Continued on page 155)

Whirling Wheels

(Continued from page 153)

those rivers up to its source and then follow it down. First there's a spring, maybe a little trickle of water. It flows along and other trickles join it until it becomes a brook, then a creek, then a river—and the river in our plant is the assembly line. Get it?"

They did, and approved. So that by the time the Vanderbilt Cup Race was run the next year the Herrick Automobile Company had completely reorganized its machine shops and was on the way toward a record-breaking year—at a lower price. And this after a 1907 in which the production of cars failed to beat the year before for the first time in its history; only forty-five hundred jobs were produced instead of better than five thousand. And Gil was fighting another different sort of battle.

"If you lose in that race, I'll leave you." That was Lois's ultimatum, delivered with anxious, worried eyes. "I'm almost a widow now. I'm due to become a real one. If there were anything to be gained—but there isn't, you're just fighting Jim Worden, that's all! And you might be killed! What about your three boys? Where will they be? Won't you ever think of me?"

THIS was backed up, moreover, by the equally strong protests of Oliver H. Marston, among others. "Aurore," said he, fiercely, "I don't like men if you want to; men who make racing their business. But don't risk your neck to please that braggart."

"That's what I've been wanting to do, retorted Gil. "But you voted against it."

He was right. Practically every other manufacturer had a string of race drivers on his staff. A regular circuit of racing had been established and was growing. First they had driven on the thirty-mile strip of Ormond-Daytona Beach, that tide-swept expanse of Florida sand that was the finest, smoothest track in the whole world. Then circular tracks had been used, after which Vanderbilt, the man who had driven a race against time to Boston years before, offered a cup in the interests of speed and inaugurated road racing in the country. There must have been a half dozen such races run that year of 1908. They began with the First Annual Grand Prize, run at Savannah the spring before; they would end with the October Vanderbilt Cup, the crowning event of the year. And next year a new course was to be added: The Indianapolis Motor Speedway, two and one half miles of banked-curve race track. And through it all Gil had asked for racers. Racing develops engines, he maintained. It displays their weaknesses as nothing else does, and shows where they must be remedied. Only to be denied. But this time Gil would race. And did.

IT WAS a magnificent course. Roughly triangular in shape, it included nine miles of the new concrete motor parkway that Vanderbilt's enthusiasm had created. Its curves were designed for high speed driving; there was not a single cross road. Gil covered those nine miles one day at practice in less than seven minutes, with Wally Burns yelling into the gale beside him. Then there was a turn north to the Jericho Turnpike, a dirt road with houses, telephone poles and crossings on which cars ran west to within a short distance of the start. After that there was a short run north on a twisted road to the corner that came just west of the grandstand. In all, the course measured 21.46 miles, with eleven of those laps to be made—238 miles of high speed!

On the morning of the race everything was in readiness. The Herrick pit was in the row near the grandstand, manned by expert mechanics and equipped with spare parts: magnetos, carburetors and a full assortment of demountable tires, inflated on their rims. They were a great aid, those tires. The men had practiced until they could change one in less than four minutes. They also had two funnels, as big as washtubs; one for gas and one for oil, with nozzles so big that four five-gallon cans could be dumped through them at once. The handhole covers on the tanks of the car were fitted with easily gripped handles so that Wally could unscrew them before the car stopped rolling. They had a signal system all prepared, too, a method of reporting the car's position as it whizzed past. And the management of the course had a completely equipped, auxiliary repair shop over on the Turnpike, as well. Stalls were there, and tools of all kinds, and race fans could scoot across the soft dirt before the shop and make any repairs that could not wait until the lap had been finished. There was one provision: only the driver and his mechanic could do the work. There must be no outside help.

SIX-THIRTY of a bright, clear morning. It had rained a little the night before and parts of the course were wet, but a tremendous crowd had driven through the night and was already packed in the grandstand and along the course when starter Wagner took up his duties. The racers were lined up in single file, Jim in number three position, Gil in number five, when a roar came from ahead.

"We're off!" yelled Wally through teeth that chattered with excitement, and Gil raced his motor a time or two to see that it fired evenly. Other engines roared too as one by one they shot away like projectiles, leaving clouds of billowing smoke behind them. "There goes Jim!" and the mechanics shoved their car along to the starting line. Then it was their turn, and Wagner, stop watch in hand, began his countdown.

"Ten to the right—seven—six—five—four—three—two—go!"

A tear clouds of smoke from the manifolds of the exhaust pipes that stuck out of the hood at the right, a quick change of gears, and they were gone. Gil settled down behind the wheel, his goggled eyes on the road ahead, Wally half sitting, half standing in his place at the left. Peering out back of forward looking back. A white stream of concrete lined with streaks of white—fences—broken by black—the crowd. Rising, falling, curving beneath their wheels. Up the grade of one of the "roller-coasters." Its summit looked like the jumping-off place ahead of them, and suddenly fell away into a ribbon of road on the other side, every inch of it known to these two men. Jumping-off place—that is exactly what it was. They flew from the tops of those rises, fully sixty feet of flight before the wheels took the ground again. But they scarcely knew it, the trajectory was so level. All of that first nine miles was equivalent to flight, so smooth was that road.

AHEAD of them for a split second as they leaped from a high spot they could see a black speck in the center of white ribbon of road. Their leader. A long curve—it seemed only two breaths since they had started—and they were bouncing over the rougher Long Island dirt. Rear stuck shoulders and chrome vanadium springs let her bounce; second a corner. Houses, telephone poles the black and white of a crowd, dust in the air. Zip! swish! roar! The corner gone and wide open again on the backstretch.

"There's one down!"

Wally's yell, a backward flash of a motionless racer beside the road, with two figures bent over it. Already, before one lap was finished!

"Number four that was, Jim's ahead now!"

Ro-o-o-a-ar! Telephone poles looked like a picket fence. Another corner. Ease up on the throttle, take it wide, then cut her in. The now familiar oily

(Continued on page 156)

30 DAYS FREE TRIAL

Battery or All-Electric OPERATION

HERE is the great value offer of the day. Test and try this powerful seven-tube RANDOLPH RADIO for thirty days. After it **brings in stations from near and far with amazing clearness—with easy one-dial tuning—after it really equals any radio you have heard—after you are more than satisfied then you can buy it direct at factory prices. Every RANDOLPH must make good before it is sold.**

The RANDOLPH SEVEN-TUBE CONSOLE Illustrated here can be had for use with batteries or **connected direct to the electric light socket—absolutely battery less—no batteries, chargers or acids—just plug in and tune in.** 100% efficient either way. Its construction and performance have been tested and approved by leading radio engineers and authorities—by leading radio publications and laboratories.

7 Tubes—Single Control

One drum dial operated by one simple vernier control tunes in all stations with easy selectivity to tremendous volume. No overlapping of stations. Illuminated drum permits operation in the dark. Volume control for finer volume modulation. This is a seven-tube tuned radio frequency receiver with power transformers and power amplification. Space wound solenoid coils. Full and completely shielded. A real receiver of the highest quality. Tremendous distance, wonderful tone quality, simple to operate.

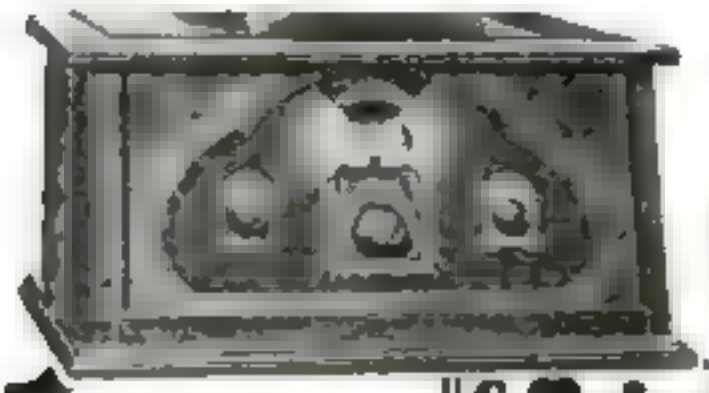
Beautiful Walnut Console
Built-in Cone Speaker

The Randolph Seven-tube Amplifonic Console illustrated above is housed in a genuine hand-rubbed cabinet with two-tone hand rubbed finish giving it unsurpassed beauty. The same expert cabinet work has gone into the making of these consoles as in the finest furniture. Has built-in genuine Amplifonic cone loud speaker of the finer quality. Accurately reproduces complete range of musical notes from the highest to the lowest pitch.

What Users Say

I have logged more than 60 stations from coast to coast.—Lloyd Davenport, Littlefield Texas. I have logged 63 stations from Cuba to Seattle the set is a world beater. J. Tamplenon, Detroit, Mich. Your set is a revelation has all others tied to the post for distance and selectivity. Waldo Powers, Vergennes, Vermont. On strength of its performances sold two more sets this week.—T. Scanlon, Orlando, Florida.

The Randolph 7-Tube Console Single Control RETAIL PRICE Completely Assembled $99



The Senior Six

Now you can have a new, modern, single-control, six-tube radio. Do not compare this set with old style 3 dial 6-tube sets selling for about the same price. The Randolph 1928 Senior Six has also been tested and approved by the leading radio engineers.

Comes in a beautiful solid walnut cabinet of hand rubbed finish. Single control. Illuminated Drum with space for logging. Absolutely dependable and very selective. **Send for 30 Days' Free Trial. You must be satisfied before you buy.**

6-Tube $55 Retail Price Single Control

MAIL COUPON NOW!

Sensationally Big Discounts to Agents

Work either full or part time and make big money. Tremendous advertising campaign helps you sell. Regardless of whether you have ever sold before, be sure to get our proposition. The Randolph sells on first demonstration. Men and women both can make money this easy way. Get your demonstration set for thirty days FREE TRIAL.

The Randolph Radio Corporation are pioneers in the manufacture of radios. All of its vast and unlimited resources have been used in creating and perfecting of the Randolph Receivers. Because of our long and successful experience in the radio business, we are perfectly confident in sending out a Randolph Radio on trial. We know what it will do. Mail us the coupon now for the greatest radio offer ever made.

Use This Coupon NOW!

Randolph Radio Corporation,
711 West Lake Street, Dept. 377
Chicago, Illinois.

Send me full particulars about the RANDOLPH Six and Seven-Tube All-Electric and Battery Table and Console Sets with details of your **30 Day FREE Trial Offer.**

Name_____

Address_____

City_____ State_____

Mark here ☐ if interested in Agent's proposition.

RANDOLPH RADIO CORPORATION
711 West Lake Street Dept. 377 Chicago, Illinois

Whirling Wheels

(Continued from page 154)

sensation of rear wheels skidding. The deft twitch of the wheel to catch that skid at just the right moment. Then down to the floor with the throttle again. More curves—always thicker with that black crowd than anywhere else—why?—and another sharp corner. The blurred bulk of a grandstand. So soon?

"Twenty-one!"

Wally had caught the flash from the pits. Good time, twenty-one minutes. But Gil could do better. Once more the swoops of the roller-coaster again the black dot far ahead. But in sight. First time Jim had appeared in sight. More white road, smooth as air, gray road, with dust hovering. Not many puddles. The corner—

"Brakes!" Gil yelled sidewise to Wally. "Loose!"

THEY had relined their brakes the day before. Maybe they had set them too tight for now, after one lap, they would scarcely hold. Gil had had to take one hand from the wheel to sense the emergency—and return it to the wheel at once to stop that too-fast swing. Gosh! They missed that corner telegraph pole by a hair! But they missed it.

Wally on his belly, reaching through the floor while a surge of dust rose around his goggled head. Taking up the brakes. Good boy, Wally! Another corner. Brakes felt better. Curves, corner, grandstand. No yell from Wally this time. He was still on his belly. Easier now. Less bouncing. It was done: he was pumping oil. Whee-e! Up the first rise. Who-o-o! Down the other side. That black dot was the shape of a car now. They were closer. "Gas!" and Wally opened the auxiliary on the carburetor a little. They pulled up on the one ahead. Such speed! The long curve, the end of concrete ahead.

"It's Jim!"

He was lost in a cloud of dust—and they hurtled into it just behind. Plunged on better than sixty, with only a few hundred feet of road visible ahead. Then a black something—that grew plainer. Jim was slacking a little for the rough road? No, the curve—and that corner. They hit it one after the other with less than two seconds between them.

"Get him!"

Down on the throttle again, with only one other thing in the whole world—that black, double-headed bulk ahead. One of those heads bent forward, the other showed white and black alternately as his goggled eyes looked back. "Get him!"

THERE is something a race driver acquires. Hours of driving do it, hours of sitting in a hurtling catapult that roars and bounces beneath him. It is a sense, very positive yet almost indefinable, of feeling that car and he are one and the same. "I would do this and so," thinks the driver, and does it. With the car, automatically. He does not think, "I will pull my wheel so much. I will push my throttle so much and accomplish this and that," he thinks "I will do this,"—and does it. In the same way that a pedestrian walking along the street turns aside and enters a door. He does not debate the turning; he does not send orders to his feet to turn, to his hands to open the door—he does it. So it was with Gil.

"Get him!" yelled Wally—and Gil "got" him. It was Gil who closed that gap, not a four-wheel projectile; it was Gil who raced along that dusty road. With Jim. It was Gil who saw the other man moving backward instead of holding his position in the corner of Gil's eye; who finally lost sight of him and saw only a clear road ahead; who threw on a little higher burst of speed—

"Got him!"

—and took the (Continued on page 157)

Whirling Wheels

(Continued from page 140)

center of the road again. And it was inside Gil that the cry of "Catch him!" now changed to "Keep ahead!"

Up to that moment there had been nobody behind him at all, as far as he was concerned; now there was nobody ahead. The thing inside had switched the title of its flow. "Chase" had changed to "Flee!" With Wally's eyes turned more often behind than ahead. Only one thing ahead now—those cattle that think it a smart to dash across the road. Supposed to be humans. The first thrill of the race over moved to the roar and flash of hurtling monsters, the confounded fools wanted to play!

"He's dropping back!

Swoop! Through curves. Swing wide, cut in, straight again. The wheels not wheels, but projections of Gil's thoughts, the brakes—they worked nicely now—his wish; the rear wheels that skidded were himself. Zip! Past the bulk of a grandstand.

"Pits! Gas 'n oil

HAVE to stop the next lap. Lose precious seconds taking on fuel; maybe minutes, if one of those fabric tires was worn too thin. The only place where the machine entered in. All right, add up some minutes. Faster!

"He's out of sight!"

They seemed to crawl along that concrete ribbon. Up—as though they would go on into the heavens, down—a little heart-stopping drop. Up, down. Curve.

"He's two miles back!"

The long curve again. The sharp line where white concrete turns to brown dirt. Flashing trees, stone walls with black things on them. The corner, the Turnpike, the flashing telegraph poles—and a bewildered pedestrian!

"Get out of there!"

Standing in the middle of the road! Crouching, as though to leap! Which way? Motionless! A twist of the wheel. Too sharp! You can't frolic with a catapult. A skid—and chaos! Crash! The world reeling. Crash! Over and over. Crash! Darkness.

"Where's Wally?"

The world still reeling, but Gil clawed himself to his feet. "Where's Wally?" Over there a battered thing that had been the catapult part of him. Men, running toward—a motionless bundle of something, crumpled. Wally! He ran. Someone was terribly hurt. He knew it; he could feel the pain. He charged through the crowd, knocking men aside. They staggered and stared. He flung himself down beside that bundle.

"Wally! Hurt, boy?"

THE tow-colored hair was red, the eyes, white where the goggles had been, were closed. He gathered it up in his arms. "Wally!" The eyelids lifted, and clear, bright eyes looked up at him.

"We got him!" whispered Wally.

"All right, Wally? Not hurt?"

"Me? . . . Now . . . I'm . . all right."

He was lying. Gil knew it. He could feel the pain himself. He hugged those limp shoulders, and the reddening hair starred against his breast.

They're coming, boy. They'll fix you up. Hang on, Wall.

The dirt-smeared face looked up at him—and grinned!

"Sure!" Then he seemed to gather himself together and his eyes grew brighter. "Go get him, boss!"

He whispered it, and Gil's arms tightened on a something that was nothing.

"Good God!"

"What's he crying about?" some voice wondered.

"Aw, nothin'. Nerves, maybe. All shook up, poor devil."

(Continued on page 158)

Whirling Wheels

(Continued from page 157)

But he saved that guy's life all right."

"And did you see him fly through the air Like a rock with a rag around it

"Here they come. Easy now."

And blessed darkness swept down again. With the roar of another passing catapult resounding in his ears.

For The Game went on. Dead? Disaster? They are only a part of The Game. Inside, they are called, the men who race and not infrequently they are so named by the very ones who stand, addle-pated, in the middle of a road. But the God of Speed must be served, let Death stalk where it will. The Game went on.

Jim Wenden never passed him. So they told Gil at the hospital. A fan blade worked loose on Jim's motor and cut the radiator to pieces the water leaked out and we had to stop or melt his motor. A Locomobile won that race. It covered the distance in four hours and forty-eight seconds, average speed of sixty-four and thirty-eight hundredths miles an hour. Splendid time with an American made car—Gil's head turned on his pillow.

Are you taking care of him?

THEY had. Gil himself was not so badly hurt. Being under the wheel was what had probably saved him. He was thrown free at last. he realized what a bustanded had said and escaped with some broken ribs and a collar bone smashed. That was all. He insisted upon being taken home, which they finally permitted, and was met by a Gail who wept.

"There, honey. I won't race any more."

"Thank God!"

"If I'd only listened!" Tears rose in his eyes. "I . . . "

She sobbed. "Oh Gil. Poor Wally!"

"Bless your heart!"

Nat did Gil ever race again, except standing on a concrete floor in a great room that he built after he had recovered, and dedicated to the memory of Wally Burns.

It was a huge place that new experimental room. It adjoined the well-equipped laboratory where chemists and metallurgists were beginning to hold forth. For science was now finding a place in the manufacture of speed, and the uncharted course that car and driver pioneers had been compelled to follow was slowly changing into charted ground.

THIS new room contained one of the first dynamometers, an electric affair with a panel board on which were electrical recording instruments of all sorts. It was supplemented with thermometers, pressure gages, banks of metal and glass. As fast as a new instrument was devised it was installed, with a corps of men who kept steadily at work. It was the Herrick race course.

There it was that men began to devise a self starter. The new distributor system was proved out there, replacing the magneto distributor. A dynamo arrangement was also put through there, though there were some who maintained that an automobile engine was not designed to run an electric lighting plant. Gil tested it, though, and thereafter all his crank cases had brackets cast integral with them, so that if a purchaser wanted electric headlights instead of Prestolite gas lamps, he could have them for a small extra charge.

It was there that Gil's first six was tested. Three pairs of cylinders cast en bloc, with a crank shaft that was drop-forged, then twisted so that its throws were separated by sixty degrees instead of one hundred and eighty as with the four. They tested it on the dynamometer, found its horsepower on the brake and on the drawbar, measured its torque and its efficiency. Then they set it in a frame—a pressed steel one, with three-point suspension, and ran it over the

(Continued on page 159)

Whirling Wheels

(Continued from page 156.

roads, after which they tore it down again and measured its wear. It was so good that they announced two 1910 models, a four and a six, and the Wenden crowd was green-eyed

But not for long, because in the middle of that year Jim Wenden announced the event that Gil had predicted the formation of Motors Incorporated. With three models, a four and a six which were already in production on the plants he had taken over, and a new six which he was making in the Detroit plant It had taken him several years to do it, and he had been treading on eggs by way of the stock market, but there it was

"Some outfit!" was the way Gil commented on it to Oliver H. Marston, in whose private office he was sitting. "Look at what he's taken over. Three plants that were staggering, every one of them. All ready to drop, like rotten fruit.

"WELL, perhaps he's got the cash to run them," suggested Mr Marston. "Nothing like picking up a liability and turning it into an asset.

"It takes more than stock gambling ability to do that, as I [illegible] All that man ever did was to play Wall Street and buy anything he thought he needed. Or bluff it out of somebody," with a laugh. "Which reminds me. I want to borrow some money on a personal note

Mr Marston's eyes narrowed speculatively. "To do the same?" he asked. "That's one thing I never could accuse you of, my boy; don't do it."

"I won't yet," said Gil with a grin. "And anything I do will be talked over with you first, Mr Marston What I'm after now is control of the Herrick Automobile Company I can't play with fire until I get some insurance. Maybe the next time I won't be able to bluff Jim Wenden. I'm going to own more than half of the stock."

"H-m-m! Very laudable ambition But it will cost you some money Know how much?"

"Yes. I need two hundred shares That means a million." He said it as coolly as though he had forgotten the time some years ago, when he had driven three times around a race track to earn the right to borrow ten thousand. "I've got about half of it, so if you'll let me have the other half—and I've got the options all signed, too. Most of them in Wendenville. They took a look at the cash they could get back on a hundred dollar investment, and fell.

"What is your security?"

"Three hundred shares which I couldn't sell because no one would buy," with a chuckle

MR. MARSTON joined him in that, and pulled out a drawer of his desk from which he took a pad of blank notes and filled one in. "Sign it," he said, and shoved it across the plate glass. "You won't need an endorser; not with that security" He might have added that he would endorse it himself if necessary, but held that back; it doesn't do to say too much

"I don't have to tell you that old Zach isn't selling," said Gil as he blotted his signature, and Mr. Marston chuckled again.

He had met old Zach Wenden several times. That huge man he was still sizable, though his advancing years had bent him a trifle and his beard was white—had come to see Gil, who had taken him to call on the banker

"Mr Marston here is the first friend I ever had" That was the way Gil had said it the old gentleman remembered it well With a little accent on the "first." "He made my life worth living in Wendenville, in spite of that no 'count son of his

Then big Zach [illegible]

Whirling Wheels

(Continued from page 156)

voice had rumbled a good-humored refutation of it, his shrewd black eyes had twinkled. "Oh, I don't know. Reckon maybe my boy Jim's got his eyes. How 'bout it, Mr. Marston?"

And the banker had agreed. "Maybe so," he had, and shaken Zach's hand with an understanding grip.

They had understood one another from the first, those two. They were still playing the game of living, but not quite so intensely, and had time to observe. The banker remembered distinctly how Gil had laughed tolerantly at their remarks. Well, Gil might not laugh with that accent later on, he might discover what they meant. But he would have to do so himself. There are some things men won't believe, even when told them by their best friends. Look what Gil was doing now—and his attention came back to the present.

No, sir, Gil was saying. "I wouldn't let old Zach sell out if he wanted to." Then, with a warm light in his eyes, he added—or something like it—after which he shook hands quickly and hustled out of the office.

Jim Wenden's crafty scheme to "get" Gil has been balked. He has been passed on the speedway—and at what a price! Will he be made to pay, at last, for the years of bullying, trickery, and insult which he has heaped upon Gil in vain efforts to gain the mastery? There's a big surprise in store for you in the final installment, in next month's issue.

"I'm Going to Send My Boy to College"

(Continued from page 56)

total. But from this college-bred minority of nine in a thousand industry draws somewhere between *one fifth* and *one half* of the fellows who are leading the other 33,000,000.

And I am planning to send my boy to college because I want him to be the one in a hundred who gets the best breaks in business life.

I admit there's something to the argument that even without a college training, the boy with real ability can make progress. But I can't overlook the great numbers of opinions from business leaders who say that the college trained man makes better speed—and that he makes it because of his college training.

Take just one such opinion, parallel to many which I have heard. It comes from J. C. Penney, who owns 550 department stores in forty-six states. Of the college men coming into this huge business of his, Mr. Penney declares:

These men are going to the top sooner or later and, *because of their superior mental training*, they are going to run more rapidly than the men of average education."

NOW, whether or not college education is actually as important as all this, remember that big business men *consider* it to be this important. And since they feel that way, they're going to hand out their good jobs to college men.

When I go fishing, I go where the fishing is good, and I use the sort of bait that fish are taking. And it's plain, from this universal attitude of big business men, that the best fishing for jobs, today, can be done from the commencement platform with a college diploma for bait.

The big corporations everywhere are combing the college crop each spring for future executive material. Some of them have personnel officials whose whole duty is to select and train each new batch of college-bred employees.

(Continued on page 161)

"I'm Going to Send My Boy to College"

(Continued from page 160)

To Yale graduates in 1925 there were offered through the Yale Bureau of Appointments 500 jobs in 188 companies. They tell me many other colleges have similar employment bureaus through which the graduates may get a fine start.

Besides that, the boy who goes to college makes a great number of friends from all parts of the country. Through them his eyes are opened to many fields of opportunity that the mechanic, in his limited little circle, never knows about. I know of one boy who graduated from a small college last June and to whom seven jobs, each with a promising future, have been offered through his friends in previous classes. One of these jobs was in Cincinnati, one in Cleveland, two in Chicago, one in South America and two in New York.

THAT shows how, just through his college friends alone, the university graduate's job-hunting horizon is widened. And everybody is pulling for him. The big corporations come seeking him; his college placement bureau, his alumni association, his professors—yes, and the fathers of the girls he meets at college social affairs—all these are only a few of the possible helpers in getting him started.

And on top of that, the colleges are developing vocational guidance experts who give the undergraduates valuable assistance in finding out what they're best fitted for in life, and then in picking the courses that will train them for that vocation.

Finally, while the noncollege men in executive positions think highly, as I've shown, of the university graduates, the executives who themselves are college graduates tend to pick their assistants almost exclusively from the colleges. Maybe that's snobbery, and maybe it's sound business judgment. Anyhow, it's a practical fact.

Now admittedly, with every year, a greater proportion of college graduates are getting the two million administrative jobs in American business. Hence with every year there will be a corresponding increase in the demand for other college men to become their assistants and start up the ladder they have climbed.

Compare all this wealth of future opportunity for the college man with the limited opportunities ahead of the high school boy who wants to become a skilled mechanic.

There are probably about a million boys of high school age who must go to work each year. And there are only about 175,000 apprenticeships open to them in the highly paid trades.

ON the other hand, according to the National Industrial Conference Board's figures, there should be about 40,000 entirely *new* places open annually in the administrative field for which a college education is known to be the best preparation. About 40,000 new openings for men of executive caliber—wholly aside from annual replacements! And the engineering colleges—which in my opinion give the best technical training for such positions—graduate only about ten thousand men a year.

So there are, roughly, four of the better jobs for each technically trained college graduate; but there's only one apprenticeship in the highly paid trades for every six boys of high school age who go annually to work.

That's why I want my boy to go to college, and it's also why I want him to take an engineering course. But even if he takes a general academic course, and so becomes one among approximately 80,000 annual graduates, instead of one among 10,000 engineering graduates—why even then he'll be one among the privileged few. The personnel director of a great corporation in New York, who has devoted years to this

(Continued on page 162)

"I'm Going to Send My Boy to College"

(Continued from page 161)

very subject, declares that American industry can absorb more college men annually than the colleges are turning out now, or than they will be turning out for a long time to come even with the rapidly increasing enrollment.

But look once more at the skilled trades. Even after our one-boy-in-six has succeeded in becoming an apprentice, he's likely to have a hard job getting work at his chosen trade.

For instance, in New York City, in the building trades, they say that apprentices have been going back to jobs as office boys, errand boys and shipping clerks—because the building contractors don't give them work. A recent survey of conditions among the bricklayers in fifty-eight cities showed that there was room, even under the union restrictions, for 10,000 more apprentices than the contractors were employing. In 1925, in Boston, thirty-five to forty percent of apprentices enrolled during the preceding year in the building trades were unemployed.

SO WHEN I think of my own boy's future it's pretty clear to me, both from the statistics and from my own experience, that he'll have the odds heavily against him if he tries to follow in my footsteps, but that if he goes to college the odds will be all in his favor.

Besides, I object to the merely financial arguments, to which Mr. Payne confined this discussion as so many others do. After all, there's more to life than just earning money. For instance, there's the amount of pleasure you can get out of your work, and the amount of pleasure you can get out of your leisure time.

Now I think that only the educated man knows how to get the finer pleasures out of his leisure time; and I know that only the educated man can get pleasure out of his work, because it's brain work, not mechanical routine.

A mechanic is only a machine. He may be as simple a machine as a hammer is simple. All a skilled mother has to do for his pastime is to drive nails and pound away deftly. Or, in some trades, a mechanic may be a rather complicated machine, as a locomotive is complicated. But it took brains to design the locomotive and it takes somebody's brains to run the mechanic.

True enough, his job requires intelligence and good habits of workmanship. But it doesn't require real brain work. And that's why his job is irksome—because any form of mental effort is more pleasurable than the routine drudgery of wrestling with a stock-and-die or slapping on mortar with a trowel.

It all summers down then to two facts. Good money is paid for brains and not brawn, and the real pleasures of life are mental and not physical. The old recipe for success is to get pleasure out of your work. If that's correct, don't be a mechanic. Go in for brain work.

BUT brain work isn't possible unless a fellow's brains are *cultivated*. And the boy who gets caught up in manual labor may never even discover that he's got brains to cultivate. The human mind isn't equipped with a self-starter. It takes education to start a boy's brains to working inside him.

So, take a plumber's word for it. Anybody who sets out to raise his boy to be a plumber is going to let that boy in for a sad awakening.

But the plumber's boy, if he has any brains at all, only needs to have them cultivated in order to get a whole lot more out of life than his dad was able to.

And unless all the statistics are wrong, unless all the opinions of big business men are wrong—unless seven hundred years of history since the founding of the first great universities are wrong—then the college is the place to cultivate brains both for success in business and for enjoyment of life.

How to Get the Most Out of Your Radio Investment

The Popular Science Institute has prepared a booklet that gives definite and helpful advice in buying, installing and operating a radio outfit. This 30-page radio booklet can be obtained for 25 cents from the Popular Science Institute, 248 Fourth Ave., New York City.

Why Building Plans Go Awry

(Continued from page 88)

with a high-class clientele, whose fee is ten percent of the cost of a building, do not usually charge anything for redrawing a design. But the cost of changing actual construction must, of course, be borne by the client. Such changes happen often enough. There was the case of a woman who ordered casement windows. Casement frames were placed in the walls. Then she vetoed casements for a room on the exposed side because they might let in rain. It is rather difficult, in fact, to make such windows storm-tight. She got narrow side-weighted windows, equipped with lead weights instead of the usual cast iron so as to fit in the space. The alteration for a few windows cost $100."

WHETHER an architect should seek to guide his client into a straight and narrow path of artistic economy or should cater to his penchant for vacillation and revision is a question that has been frequently discussed. Some think an architect should, like a doctor, prescribe what is best for the patient—that is, client—and see that he takes his medicine. Others hold that such a course is impractical and futile. People believe in doctors but they have slight faith in architects, and resent too much guidance in respect to the style and layout of their homes. The result of this widespread attitude is that not a few architects proclaim their platform is to give the public what it wants.

Among those who believe an architect owes more to his client than ready acquiescence in every flighty notion is R. A. Cochrane, who is associated with Frank J. Forster in the planning of distinctive homes. People can be reasoned with, in a diplomatic manner, Mr. Cochrane finds me. They can be made to understand a design by explanation and model, and they can be persuaded to stick to it instead of losing themselves in a morass of indecision, botching alteration and unwelcome expense.

The evils of plan changing have been lately campaigned against by The Architects' Small House Service Bureau, a national organization of public-spirited architects endorsed by the United States Department of Commerce. Plans are sold for an average price around $30 a set and houses are built from them by local contractors in various parts of the country, usually without supervision of an architect. Buyers think up changes, local builders offer suggestions, friends and relatives are liberal with advice on alteration. In consequence the house may be spoiled in looks, in construction or in both. It is certainly unsafe for the rank amateur to meddle with a carefully thought-out design.

IF CHANGES are desired submit them to an architect and have them clearly indicated in the working plans. A proof of a builder's incompetence as an architect is his vague sketch or his pallid apology for a blueprint which is not in scale and shows undecipherable figures. Such a plan may be a masterpiece, but the chances are a thousand to one that it is but the fuzzy reflection of the builder's confused and rule-of-thumb mentality. The average owner, to whom a real plan is enough of a Chinese puzzle, must be totally obfuscated by such output, yet perhaps because of that fact he seems impressed and takes a chance.

Some few regular architects can be fairly criticized for their exaltation of art at the expense of practicality. For example, some design a frame house to sit squatly on the ground. Every practical builder knows a high foundation protects against dampness, decay, insects like white ants, and fire in leaves or rubbish alongside the house. With a low foundation the price of beauty is too high. Use and looks should be harmonized.

Here Are Correct Answers to Questions on Page 46

1. Because of the common phrase "beer and skittles," many people imagine skittles are something to eat or drink. Skittles is, in fact, a game much like bowling, played in the Netherlands.

2. The Amazon basin in South America, which covers more than two million square miles. The population is less than one person to the square mile. The reason is too much fertility. The country is covered with an almost impassable jungle of natural vegetation.

3. The island of Porto Rico resembles other islands in the West Indies in being very well watered on one side and not well provided with rainfall on the other. This is due to the direction of the prevailing winds. Extensive districts have been placed under irrigation.

4. The famous Magdalena Bay, on the west coast of the southern part of the peninsula of Lower California, although an excellent harbor, has no supply of fresh water. Lower California is one of the most nearly waterless countries of the world.

5. Although the Alaskan winter is cold and long, the summer is warm enough for the growth of many useful plants.

6. The great iron ore region is in Michigan and Minnesota, bordering on Lake Superior.

7. Two depressions in California possess this distinction. Death Valley is one. At the bottom is a small lake of brine nearly 300 feet below sea level. It is the lowest point in the United States. Farther south is the basin occupied by the Salton Sea. This, too, is below sea level.

8. An imaginary line drawn north and south across the Pacific Ocean to mark the point at which the marine day changes. Ships at sea are accustomed to take the ship's time from the sun. Accordingly, if a ship traveled clear around the earth, it would either gain or lose one day. Without some agreement as to which day was which, the ship's captain would never know. The International Date Line determines this. In the middle part of the Pacific the line coincides with the 180th meridian west of Greenwich. Eastward of the line is the earlier day. For example, it is Sunday east of the line when it is Monday west of it.

9. Such ornaments are greatly prized among the negro natives of Kenya Colony in the eastern part of Central Africa.

10. This is the famous Suez Canal. It crosses the isthmus connecting Asia and Africa and allows ships to pass from the Mediterranean to the Red Sea. The Suez Canal is ninety miles long, nearly forty miles longer than the Panama Canal.

11. The most numerous people in the world are the Chinese, there being at least 400,000,000, possibly as many as 500,000,000. Nearly all Chinese speak languages belonging to the same general group. However, there are many dialects.

12. The famous 1,200-mile Chinese Wall, in China, was built more than 500 years ago to keep out barbarians from the north.

The Human Mind Craves Wonders

(Continued from page 44)

restoring strength, relieving rheumatism, backache, kidney, liver and bladder trouble and whatnot.

From time to time dozens of these or similar devices have been advertised and sold widely in this country. There has been, for example, Addison's galvanic electric belt that can be purchased for $1 per dozen, but which retails for $2.50 each. There is the electric chemical ring supposed to cure diseases caused by acid in the blood. When its promoter was brought before the postal authorities, he volunteered the information that his receipts for one year were $45,000 and that it took fourteen people to help him supply the demand for his device. The Owens electric belt is supposed to knock rheumatism and stomach trouble, while the Sanden electric belt will cure, it is claimed, almost anything. Practically all of the electric belt concerns have been subject to fraud orders issued by the Government, denying them the use of the mails. But the group of persons ready to be mystified by electricity is perennial.

IN THE period between 1910 and 1916 thousands of persons fell for the gas pipe cure. A dozen devices were put on the market consisting of a piece of nickel-plated pipe closed at both ends and filled with some dust or chemical substance of little or no value either physically or monetarily. To this piping were attached one or two flexible wires, at the free ends of which were small disks with elastic bands or buckles so that they could be fastened to the wrists or ankles of the user. This cylinder would be put into cold water and the patient would lie patiently while he was presumably receiving some sort of force, characterized by the inventor of the first of these devices, one Hercules Sanche, as "'doductron.' The first device was called an "electropoise," again conforming with the magical word "electricity."

Later examples were the oxydonor, the oxypathor, the oxygenor and the oxybon. The Government issued fraud orders against all of them. The price paid by some of the victims varied from $5 to $55 for the little apparatus that cost about $1.25 to manufacture. The claim of "cure-all" is sufficient always to attract the unwary.

CONTRAPTIONS such as these are sold with preposterous claims as to their efficiency. Nevertheless, the magic that lies in some of the modern medical discoveries actually is far more marvelous. Consider the recent discoveries relative to light. For years mankind has suffered with the disease known as rickets, in which the long bones of the body become soft and do not grow satisfactorily. Thousands of children have been bow-legged, have had little pot-bellies and flat chests with beaded ribs, because of this disease. When Doctor Huldschinsky first suggested that light might aid in preventing this disease, his views were greeted with rather calm disdain. But with the passage of time the work of Dr. Alfred Hess, of Dr. Steenbock and of many others has shown that regular exposure to ultra-violet rays will prevent the disease, and will even stimulate the body to bring about a cure if the disease is caught in its early stages.

The phenomena is wonderful and it has been demonstrated on animals as well as on man. Here is the difference between the unsupported claims of Abrams and the brilliant scientific demonstrations made by qualified research investigators.

One of the significant facts brought out by research in the present century has been the marvelous effects of insignificant doses of certain substances. The human body is sometimes sensitive to ex- (Continued on page 166)

The Human Mind Craves Wonders

(Continued from page 165)

ceedingly small doses of proteins or indeed of some inorganic chemicals; for instance, in hay fever and asthma the symptoms are the result of a special sensitivity to some protein. The body is so sensitive that the protein substances mentioned may be diluted down to a millionth part, and one drop of this placed in the eye of a sensitive person will produce an inflammation.

In the prevention of goiter, iodin is given in doses of one tenth of a grain once a week for ten weeks to children.

The anaphylactic reactions, or the response of the body to a protein when it is sensitive, is so powerful that an animal may be killed as though by a stroke of lightning if it is first sensitized to a protein and then injected with a tiny dose of the protein substance. It is hardly surprising that people will believe anything in the field of quackery in the presence of knowledge of the phenomena that have been described without any accurate comprehension of the mechanism.

THE American public is most afflicted of all nations in the world by peculiar systems of healing and by fraudulent cures for all sorts of diseases. The index file of quackery in the records of the American Medical Association contains more than 125,000 cards representing various forms of quackery that have preyed on American credulity.

The cures for cancer, for tuberculosis, for the other ills of mankind are legion, and new cures constantly appear. There are at least thirty-seven cults of religious healing, to all of which the magical word "science" is somehow attached. There are manipulative cults, faith-healing cults, electric cults, mechanical cults, nature healing cults, dietary systems, and hot air treatments, if all of those that precede cannot be accredited to the one named last. Practically all of the records of recovery credited to any of these fraudulent systems or devices may be classified as faith healing, curing the victim of a disease that he does not have, or acting as a sort of soothing syrup while the natural healing powers of Nature—the tendency of living tissue to get well—carries the afflicted one to recovery.

Physicians have long given thought to the means by which human beings might be disabused of their credulity and brought to a realization of what constitutes fact in medicine. Apparently the only hope is in education of the public so that people will be just as interested in reading about the human body, the manner in which it is built and its functions as they are about airplanes, motor cars and radios.

BUT there will always be those who enjoy the spectacle of a miracle. Perhaps people suffering from mental disorders, who are not actually sick but only think themselves so, will continue to seek shrines, faith healers, psychoanalysts, and various forms of religious healing. But the man with a knowledge of bacteria and the way in which they cause disease, who knows the futility of conjuring methods, who knows enough about electricity, physiology and physics to see the fallacy of the claims of an Abrams or a Wilshire, is not going to spend his money in fraud when scientific medicine has something certain to offer.

There are enough wonders in science itself in the mysterious powers of the glands of internal secretion, in the magnificent regulating system that controls the temperature of the body, the heartbeat and the respiration, in the human eye, the most marvelous photographic device ever invented, in the brain, which sends impulses to other portions of the system that lead to action. These wonders, once understood, are far more miraculous than any of the things purveyed by the miracle monger—and they sell for less.

Myths About Mars Exploded

(Continued from page 16)

the surface of Mars under a noonday sun surpasses the melting point of water. During the Martian night, however, the temperature evidently falls to sixty degrees below zero, or lower, and it is probable that the equator is not so warm during the summer as the portion or pole which is turned toward the sun at the time, and which is experiencing the phenomenon we call the "midnight sun.

Astronomers now agree that Mars has water, though in no large amount. That it possesses a meager atmosphere and a temperature which at least permits the existence of liquid water upon the surface for a part of the day. These facts, coupled with the observed changes of the dark areas as the seasons come and go, strongly support the theory that vegetation is responsible for the markings.

IT IS probable that most, if not all, of the oxygen in our atmosphere is the product of vegetation. If all plant life on earth were to be destroyed today it would only be a short time, geologically speaking, until oxygen, extremely active chemically, would disappear entirely as a part of the atmosphere, having combined with the earth's crust. The presence of oxygen, therefore, in the atmosphere of Mars may be taken as certain evidence that vegetation now exists, or has recently existed, there. The former view is probably the correct one. Venus evidences neither water nor oxygen, making any there highly improbable.

Martian vegetation may resemble the tundra areas of the great plain of Siberia, for this hardiest of plants would possibly be best fitted to cope with the low temperatures of the Martian night. The more may not seem certainly argue, "Where vegetation exists, animal life, possibly intelligent, may also exist." Granted, but I would place great emphasis on the word, *possibly*." It is a long jump from Mosses to mammals, from mushrooms to monkeys, and from these to man.

The chance that we may some day communicate with Mars appeals to most people. Let us calculate the chance which an observer beyond our earth would have just in establishing communication with us. Geologists tell us that the earth is at least a billion years old. Man has not existed more than a million years, or one one thousandth of the earth's age. The distant observer's chance, therefore, of finding anyone at home here would be only one in a thousand. Since civilization is certainly not older than 10,000 years, his chance of finding *intelligent* life decreases to one in 100,000. Finally, if radio is to be the ultimate means of communication, our observer's chance of getting some one on the air is much less than one to fifty million.

BUT, "why should the earth be especially favored with life intelligent above that of all other planets?" I hear some person argue. To which I reply: "Of all the planets, the earth is so situated that liquid water is present in large quantities throughout the year. An abundant atmosphere and uniform temperature are situational incentives to life and, while I cannot disprove the existence of Martian animal life, I regard the presence of its higher forms as an improbability.

Astronomical research has shown you a planet very unlike our own, to be sure; but why should it be like the earth? It is reasonable to expect Nature to give us infinite variation. Many will be disappointed, no doubt, that I cannot find evidence for intelligent life on Mars, or recommend the planet to them for a summer home. These will ask, "But can you not conceive of life in any other form?" I can only answer: "Your imagination is as good as mine."

Getting Ready for the Next War

(Continued from page 87)

his book, "Statesmen and Soldiers of the Civil War."

This year the American Army has devoted special attention to experiments with aircraft. At San Antonio, Texas, maneuvers, Secretary Davis and Assistant Secretary Davison, Major General Mason M. Patrick, head of the Air Service, and Brigadier General James E. Fechet, second in command, were present with Major General Amos A. Fries, chief of the Chemical Warfare Service, and Major General Malin Craig, Chief of Cavalry.

To Major General Ernest Hinds, Commanding the Eighth Corps Area, and to Major General W. D. Connor, commanding the famous Second Division, was entrusted the task of devising methods for all departments of the Army to work together. At the end it was concluded that the Army Air Corps had proved its value as a reliable offensive, defensive and reconnaissance instrument.

THE American Army has formulated rather a conservative view of air power in the next war, but Rear Admiral Colby M. Chester, now retired, first naval officer to fly, has said:

"The Lindbergh flight makes fiction of the proverbial 3,000 miles of the Atlantic between the United States and Europe. The United States is no longer invulnerable, because the distance factor has disappeared."

New types of fighting airplanes are being constantly developed, such as the new Curtiss armored biplane that had its test flights at Mitchel Field, N. Y., in July. The Condor, as she is called, has six machine guns and tons of bombs.

The British claim the largest bombing airplane, weighing ten tons, carrying bombs and a ton-torpedo. This is a more powerful plane than our new Duff-Daland bomber called the Cyclops.

Secretary of the Navy Wilbur recently approved plans by the Goodyear Tire and Rubber Company for the world's largest dirigible, of 6,500,000 cubic feet gas capacity, capable of carrying gun batteries and five airplanes to defend it from fighting planes. The British recently launched two battle planes from their airship *R-33* at a height of 6,000 feet.

The most striking note in the controversy over the value of aircraft in war was struck by a mysterious unknown Englishman writing under the name of "Neon," who quotes Major General John F. Hines:

"Aircraft will always be limited as to their radius of action. They will always be dependent on favorable weather conditions. They will always require land or sea forces for the protection of their bases."

Not long ago, an American general said anti-aircraft guns would defeat raids.

"FOR they would not be such antiaircraft guns as were used during the war," he said, "although those were more accurate than anyone gave them credit for being. Five American archie batteries brought down seventeen planes with 10,275 rounds. Two American antiaircraft machine gun battalions brought down, in a little over two months, forty-one airplanes.

"But antiaircraft has improved since then. Do you know that now, antiaircraft guns are more accurate than field guns? They now make 9.15 percent of hits per hundred shots, and the Field Artillery, firing on targets on the ground, troops, trenches, etc., makes six per cent."

Progress made in antiaircraft was recently described as follows in *Army Ordnance* by Major C. G. Metzler, Ordnance Corps, U. S. A.

"They have developed better listening devices to indicate the approach of the hostile airplane, to determine

[Continued on page 169]

Getting Ready for the Next War

(Continued from page 168)

the altitude at which he is flying, to make more accurate corrections for wind, atmosphere and powder. They have learned visually to measure the rate of the airplane, both horizontally and vertically, and to plot where he will be when the projectile reaches that vicinity.

A new antiaircraft machine gun has several barrels operated by a single control that literally spray bullets upon aircraft as high as 12,000 feet. Our new four-inch antiaircraft gun can reach 40,000 feet straight into the air.

INTERESTING tests will be possible when the new thirty-seven-millimeter antiaircraft gun is fully developed. This is the familiar "toy cannon" that the doughboys used to drag with them to fire against machine gun nests. As an antiaircraft gun it will fire one-and-one-fourth-pound projectiles 100 shots a minute.

General Pershing has called unlimited development of gas "shocking to the senses," but a German manual called *Der Chemische Krieg* says gas is "a vital weapon" which will "confer world importance or even world power on the nation which shows supreme capacity in the field."

Dr. Charles L. Parsons, secretary of the American Chemical Society, said recently that when technical experts of the United States, Great Britain, France, Italy and Japan met to study the poison gas situation all had secrets to conceal.

So many are the new developments in artillery, machine guns and rifles that the losses in the next great battle will be several times as heavy as those in, for instance, the Meuse-Argonne, the greatest American battle, where we had 185,000 casualties in forty-seven days.

American ordnance experts have increased, sometimes tripled, the ranges of various machine guns and rifles, due largely to the development of a new shape for shells and bullets—the streamline boat-tail.

The point of the projectile has been sharpened also, and the whole shape is calculated to reduce air resistance, but principally, and briefly, it reduces the extent of the vacuum created in the air by the progress of the bullet or shell, and as this vacuum exerts a backward pull, the backward pull is also reduced and the progress of the projectile less impeded.

It was desired to photograph the standard rifle bullet, moving at 32,400 inches a second, but even with an exposure of 1/32,400th of a second, the bullet would move an inch. Time was reduced to one ten-millionth of a second by using an electric spark and damping the discharge.

From study of the pictures the means to attain greater range was learned.

We have improved the 4.7 gun which fired a forty-five-pound shell 8,700 yards so that it now throws a fifty-pound shell 23,000 yards. The 155-millimeter howitzer in the war fired a ninety-five-pound shell 12,000 yards, but now it throws the same shell 15,800 yards.

THESE guns also can cover greater areas, due to the split trail, with which practically all field guns are now provided, which enlarges the traverse of heavy mobile artillery from eight to sixty degrees. And by caterpillar mounts and rubber tires lighter batteries can move thirty miles an hour! During the war they moved five.

The most mighty gun in the United States today is the sixteen-inch coast defense gun that throws a 2,340-pound projectile thirty miles to pierce fourteen inches of face-hardened armor. Its hitting power has been more than doubled since 1918.

Probably the deadliest weapon developed in the last war was the machine gun. Today the United States Army believes it has the best of these in the world. (Continued on page 170)

Getting Ready for the Next War

(Continued, on page 169)

Range has been increased from 3,300 yards in 1918 to 5,700 yards.

As to the nature of the next war on the sea there are two schools of thought. The air enthusiasts, led by Admiral Sims, believe bombing airplanes and seaplanes, seconded by submarines, will revolutionize sea warfare.

Professor A. M. Low predicts an armored "submaplane," that can travel in air, water or under water. The French Navy has completed the largest submarine in the world, with tonnage of 3,000. Prof. Oswald Flamm, who designed German U-boats, now plans a cruiser submarine of 7,000 tons, 400 feet long, carrying two eight-inch guns. The most powerful British submarine is the X-1 of 2,780 tons, 351 feet long, with four-inch guns and with twenty-one-inch torpedoes. This can remain submerged two and one half days and go anywhere.

OUR own V-boats would stack up well with the X-1. Japan has ten big new submarines that could cross the Pacific and return, and her program calls for eight more.

France is pretty well ahead in the development of the other principal new naval weapon, the flying boat. The newest French creation is ninety-eight and one half feet long, weighs over seventeen tons and can carry a great weight of bombs.

Rear Admiral William A. Moffett, Chief of the Bureau of Aeronautics of the Navy Department at Washington, says:

"The first shot fired in the next naval battle will be an airplane shot from the deck of a surface ship, and the battle in the air for air supremacy will be preliminary to the surface engagement which must be the final and conclusive argument."

And the design and installation on American ships of catapults for launching airplanes is far ahead of that of any other country.

British battleships are 6,000 tons larger than during the World War. The two new ships, the [illegible] and the [illegible], carry sixteen-inch guns hitherto confined to coast defense, throwing shells 10,000 yards farther than the most powerful guns at the Battle of Jutland. These ships displace 35,000 tons and will cost about $30,000,000 each. The Japanese *Nagato* and *Mutsu* come close behind, and so do our *Colorado*, *West Virginia* and *Maryland*.

"Medical science has kept pace with new weapons," says Major Louis Livingston Seaman, who has served in every American campaign since the Spanish-American War and in the armies of Japan and Belgium, and is now president of the American Surgeons Travel Club. "The increased knowledge of antiseptics today is probably the greatest stride forward. The death rate from disease among troops has decreased in the American Army steadily, from 100.46 per 1,000 in the Mexican War to 14.08 per 1,000 in the World War."

IT IS strange, perhaps, but true that here in the United States the scientific war men are not so strong.

Major General Charles P. Summerall, Chief of Staff of the Army, says:

"In the final analysis war is the problem of a soldier with a bayoneted rifle—perhaps an automatic rifle—in his hands, going somewhere to take a piece of land held by another soldier with a bayoneted rifle—perhaps an automatic rifle—in his hands."

And General Pershing said in his farewell report:

"We are logically forced back to the conclusion that armies must still fight our battles and to win must overcome the opposing forces. Since the beginning of history man has overestimated his newest accomplishment. This has been particularly true of the means of making war."

50 Years Building Church

standing in a city where the average life of a commercial structure has been estimated by one authority at as little as thirty-five years. It is thirty-six years since work was begun on the cathedral. Fifty-four years have passed since the charter was granted for the project.

Completion will require at least ten years more—perhaps twenty if there are delays in financing as there have been in the past.

A half century, however, is not so long in the construction of a cathedral. This one, about half finished, is being built to stand a thousand years, or two thousand.

There are structural problems which do not yield to speed. St. Paul's in London was built rapidly, and it took thirty years. The Cologne cathedral, founded a little before the fourteenth century, was finished 580 years later.

WHEN the first cathedrals were built structural steel was unknown, and tradition still dictates the use of solid masonry. Massive granite blocks, many of them weighing ten tons, swing into place in the rising walls of the nave of St. John's. Except for scaffolding, no wood is used.

Roofs and ceilings are arched. Even the ceiling of the crossing, spanning an open space 100 feet square, supports itself by its arch. The flat floor of the nave, which with the crossing will accommodate more than 10,000, rests on the arched ceilings of the crypt.

Working with stone, one of the most ancient building materials, and following the traditional lines of Gothic architecture, the builders of St. John's cathedral have, nevertheless, brought the most modern science and equipment to simplify their problems.

Granite is quarried to order and cut by power-driven saws. Every block's exact weight, size and shape are minutely calculated. A motor truck hauls it alongside the wall and an electrically-driven steel crane hoists it into place in a few minutes. In the Middle Ages materials had to be hauled up long, inclined runways, and the tractive power was often human.

When the contractor prepared to build the nave of St. John's he was confronted with a puzzling situation. He visualized the piers rising ninety-eight feet, a height surpassed by few if any in the world, and above them the arched ceiling springing to its ridge 130 feet from the floor.

NOW the ceiling, he knew, would support itself once it was completed. But until its arched sides met, until the keystones were set at the very top, it would have to be held up by scaffolding. The supporting piers of stone would range in two rows, sixty feet apart. Each arch or rib would carry a weight of 600 tons. In the central clear space there would be nothing on which the scaffolding could be set between the floor and the ceiling. To be made substantial enough, the timbers would have to reach almost the entire building.

Still another problem was presented by the walls and piers themselves. As they rose far away from the ground, no intense hate stones would be afforded as working levels. The machinery for hoisting the granite and limestone would require a strong foundation. The nave floor, laid eight years before, would not suffice. It was of tile construction, supported by the arched ceilings of the crypt.

Now structural steel, barred as an integral part of the cathedral, became an important factor in its completion.

The foundations for the great sixteen-foot thick piers had been built up through the floorwork to a level with its surface, and were somewhat larger in area than the piers themselves. Using the surplus spaces on these sturdy footings as bases, the contractor had a structural steel framework erected. *(Continued on page 172)*

50 Years Building Church

[illegible]

This steel structure with beams across its top would serve as a floor to hold the scaffolding which would support the roof, but it was useful long before construction reached the roofing stage. Six electrically powered steel derricks were built upon it. Each had a seventy-foot boom or lifting arm capable of hoisting fifteen tons, and together they served all parts of the nave.

ADVANCING science has contributed various improvements not dreamed of when the cathedral was begun. It is doubtful if the original planners ever hoped that a speaker in the pulpit would be heard simultaneously at both ends of the church, about two city blocks apart. It was expected that in St. John's, as in the Old World cathedrals of that time, the listeners would be grouped in relatively smaller areas. Today there is a microphone in the pulpit. A single voice carries to the remotest portions of the church.

The builders cannot guess what new marvels of science will become available, but wherever possible they are providing for unexpected developments.

Electrical conduits are being built with capacities far greater than required at present, so that additional wiring may be installed without disturbing the masonry.

Steam will do a novel service beside ordinary heating. In winter it will be turned on to thaw ice and snow in the drainpipes which carry water from the roof down through the inside of the walls. At the gutter openings will be connections to supply live steam.

Drainpipes and electric conduits are not the largest passageways hidden behind the heavy stones of the building. A visitor may discover this as he passes one of the huge piers. Outwardly it seems to be a solid column of rock, some sixteen feet thick. But in the side there is a doorway which leads to a winding stairway two feet wide. The steps go down to the basement and up through the top of the pier. When the nave is finished they will lead to the space between the ceiling and the roof; a climb of 124 feet through a stone column. In the opposite pier across the nave will be another such stairway, and there will be two more in the west front.

AN impressive feature of the cathedral is its organ, a massive instrument with four keyboards, 7,000 pipes and a chime. It is operated electrically by an organist who sits, invisible to the congregation, watching the choir by reflecting mirrors fixed to the balconies.

The metal reeds are so delicate that they are tuned each week to offset expansion and contraction caused by changes in temperature. A motor pumps air to the instrument in St. John's. Six persons still tread upon bellows in the Notre Dame cathedral of Paris.

The great distances within the cathedral are graphically realized when one sees a visitor gazing with binoculars at the magnificently colored windows, 100 feet above the floor. Of the windows, costing at least $10,000 each, seven are nearly thirty feet tall.

When excavation for St. John's was begun in 1891 the engineers discovered that much of the surface bedrock which had been considered solid was in reality rotten. In some places it was necessary to dig down seventy-two feet.

They were not yet certain. A specimen of the rock was ground down to a thickness of 4-100 of an inch, on a jeweler's emery wheel, and its structure was minutely studied. Then it was pronounced safe.

Years later a similar problem was encountered in preparing the foundation for the nave. Before trusting a ledge of rock as a base for a pier or wall workmen would drill holes six feet deep. If unsound [illegible]

50 Years Building Church

(Continued from page 172)

rock was found, it was blasted and scooped out. Then five more test holes were drilled. There were places where fifteen feet of rock had to be removed.

The builders know the dangers of insecure foundations. The bell tower of St. Mark's cathedral at Venice, built on a damp island, fell and had to be reconstructed. Undulations developed in its floors. In St. Paul's, in London, twenty-eight buttresses cracked as a result of drainage of the sand and gravel foundation. The two western towers of famous Westminster Abbey caused serious concern some years ago. The builders of St. John's have spent more than a million dollars for the granite and concrete foundations. Each pair of piers in the crossing, with their massive connecting arch, weighs 4,000 tons, and the 400-foot central tower has not yet been built.

WHEN work on the cathedral was begun, it was realized that years would be required for completion, and construction was planned in such a way that each unit could be used as it was finished. Eight years after the work started, the first services were held in the almost completed crypt, or basement.

The huge piers rose for the crossing, and the 100-foot gaps between them were spanned with arches. This section, with the choir, sanctuary and chapels, is used today.

The eight great columns in the sanctuary, according to the original plan, were to be monoliths, single pieces of granite, costing $15,000 each. As such they would have been the largest in the world.

They were quarried on an island near the coast of Maine. The contractor had no lathe large enough to turn and polish them, so he built special equipment costing $30,000.

But the size of the columns was too great. They weighed 150 tons each, and were fifty-five feet long. After two had nagged and snapped in the lathe, permission was granted to deliver the columns in two pieces each. Even so, they were the greatest of their kind.

The task of erecting the columns in the sanctuary was a delicate one. Three thirty-horsepower engines supplied the power. Weeks were spent in making calculations for the placing of each of the shafts; the hoisting was done in fifteen minutes for each column.

As a result of financial difficulties, work lagged on the cathedral for a number of years. The passage of time has left its mark even on the wall of the nave. Just below the fresh granite blocks being placed today, there are others darker from having lain on the ground for years while funds were being raised.

THE original architects of the cathedral were George L. Heins and Christian La Farge. After Heins' death in 1907 La Farge served until completion of the choir in 1911, since when the architects have been Cram and Ferguson. Henry Vaughan was architect of three chapels: Carrere and Hastings of one.

The original plans called for a dome, then a huge spire, more than 300 feet tall, was suggested. At a most unsurmountable problem developed. The crossing was more than 100 feet square. A tower or spire erected above the space would dwarf the rest of the building, including the two fifty foot square towers planned for the west front, at the end of the nave. Only this year the architects found a solution, never before used.

The huge arches on each side of the crossing will be used as a foundation for secondary arches, rising above them. The secondary arches will intersect above the crossing, forming a square sixty feet on each side, upon which a 400-foot tower will be erected.

In effect, it will be hung above the open space of the crossing without a single extra pier to spoil the magnificent vista made.

Clothes Woven from Rock

(Continued from page 51)

Of course, iron holders, mats and stands, gas burners and gas logs, are commonly known, but not many are aware that asbestos-composition floors also are being laid, unburnable and ever-wearing.

"Your stoves and ovens are so efficient because of the same heat-wave resistant. If you started to uncover all the asbestos in your home you would have to take apart the electric wires, all your electric appliances, phonograph records, radio parts, even your telephone mouthpiece. Few common materials are fire- or even heat-proof. Only asbestos stands between us and the fire demon.

"Heating plant pipes in modern homes are covered with asbestos mixed with magnesia or a similar substance, saving as much as 180 pounds of coal per square foot of boiler surface, which in the heating season of 210 days amounts to five or ten tons. Because the majority of homes are still trying to 'beat all outdoors,' however, $300,000,000 worth of coal is still being wasted.

"IN POWER plants every hot piston stem, steam joint, pipe, strap and valve has its asbestos packing and gaskets. We could not begin to retain and handle these enormous but efficient forces without asbestos and graphite. Even electric switchboards, insulators and panels are molded from it, while tiny fibers are made into lamp filaments.

"You can live in a completely fireproof home if you desire, made of asbestos lumber and roofed with asbestos shingles or tiles. Not long ago a whole trainload of fireproof houses were shipped to a firm in St. Louis, for its employees. You can buy asbestos tapestries, rugs, table covers and even rope ladders.

"Chief of asbestos parts in motor cars are the brake linings, for which we have to thank C. W. Raymond. Back in 1903, while Ford was still experimenting, Raymond tried mohair leather and other materials, none of which would stand up under the high heat and pressure of a friction brake. Asbestos with woven brass wire solved the problem and Raymond patented the brake lining, seventy-five million feet of which stops twenty million cars today.

"Our safe steel railroad coaches were once thought impracticable, because of the difficulty of insulating against cold and rumbling. Now cattle hair between layers of asbestos keeps them at equable temperatures. Ships' bulkheads are made fireproof with asbestos boards.

"ASBESTOS is just beginning to take to the air around the motors and as insulation. But tank covers would save accidental fires, and asbestos mail bags would save letters as readily as the asbestos suit used to save the 'human comet' of bygone country fairs. He had gasoline poured over him and lighted, and then plunged in a blaze of glory into the tank beneath."

Although Benjamin Franklin had an asbestos purse—doubtless to keep his money from "burning a hole in his pocket," it was 1868 before asbestos began to be used here, for roofing felt and in cement. Years before, the French had made it into firemen's suits, to Napoleon's delight. The Italian Alhonero tried to make government notes of asbestos paper. In the '70's H. W. Johns and an English firm began to make really useful articles from the fibers, and its vital part in the growth of industry was soon realized. The tremendous expansion of mining of asbestos, especially of the "chrysotile" of Quebec, is one of the romances of the age.

In 1876 Italian miners began to toil up winding mule paths to the 8,000- and 10,000-foot Alpine mines in the Susa and Valtelina valleys. They brought the asbestos swiftly down on toboggans. In 1904 an avalanche overwhelmed over a hundred miners and their huts.

But the Italian product was too scarce and expensive. In 1878 the immense Quebec deposits were opened. The fibers were shorter, but some were long enough to be woven, and they were much stronger than the Italian. The miners followed the glistening veins, a quarter inch to several inches thick, 500 to 1,000 feet wide, for miles and miles through the fire-defended hills. The more they mined, the more was wanted. Fibers over three quarters of an inch long have never equaled the demand.

"In places," says James G. Ross, mining engineer of Canada, "almost the whole rock is fibrous. Talc and soapstone occur in the asbestos. While the fiber appears to be solid rock, it may be pulled apart in fine shreds which resemble silk threads. French Canadians call it 'cotton'."

In the vast open pits dynamite blasts huge blocks loose from the mother lode. Textile machinery cards, winds and spins the fluff which is woven like flax.

In 1879 the miners had a hard time getting $65 a ton for 300 tons. By 1890 the price of "No. 1 Crude," the highest regular grade, was $140 a ton. By the beginning of the World War it brought $300 to $350. By 1917 Canada was producing eighty-five percent of the world's supply and obtaining $900 to $1,700 a ton for No. 1. In 1919 best grades brought $1,500 to $3,000, and in 1920 select fibers, over two inches long, sold for over $4,000 a ton! Last year almost 250,000 tons crossed the American line, worth over eight million dollars. No. 1 Crude is now quoted at $523, while long fibers run much higher.

A KEEN Canadian first saw how to make shingles, cements and compositions of the very short fibers that had been regarded as waste. Asbestic, today mixed with lime or other substances, makes hundreds of articles.

Chrysotile asbestos has been found in Central Park, New York, and in Wyoming, Nevada, North and South Carolina, Virginia and California. The Salt Mountain mines of Georgia have been worked for many years, while in Idaho, near Kamiah, it is planned to make asbestos paving material. This might take the place of good intentions in warmer climes. Comparatively little from the widespread deposits of this country is acceptable to the asbestos makers.

Travelers in the depths of the Grand Canyon of Colorado have seen asbestos veins at a depth of over 4,000 feet below the rim, proving the age of the material. Indeed, it is considered the most ancient material which the hand of man has uncovered. Other deposits have been worked higher up on the walls of the canyon. Only burros are available for packing, and thus, although the fibers are six to eight inches long, strong and silky, they are hardly able to compete with Canadian fibers.

Thus the field is still wide open for the prospector, for this country supplies scarcely one percent of its needs. Fire barriers in oil refineries demand an enormous quantity. All plants which handle spouting molten materials and white hot flames have constant need for asbestos clothes, gloves and hoods. Chemical plants and laboratories must have it for filters, retorts and tanks, for it is impervious to most acids, lutestants and alkalis. Sulphuric acid vats are packed with it. Asbestos enamel makes a heat resistant film for steel and wood. Thousands of castings have been made from permanent molds of asbestos composition.

Long ago the theater adopted asbestos for its curtains. About one thousand are now made each year.

Charlie Chaplin, using an acetylene torch in one of his films, set his baggy trousers afire, but asbestos underwear saved the world's best-known comedian from injury.

INTO thousands of cultured American homes will come Dr. Eliot's Five-Foot Shelf of Books on Christmas day. Every year more people give their loved ones this most lasting of gifts.

It took twenty Centuries to make *this* Christmas gift for you

SIX YEARS before he compiled his famous Five-Foot Shelf of Books, Dr. Charles W. Eliot of Harvard wrote an essay called "The Happy Life."

"Books," he said, "are the most constant of friends, the wisest of counsellors, and the most patient of teachers. It is a mistake to suppose that a great deal of leisure is necessary. A few minutes a day, devoted affectionately to good books, will make all the difference."

All the difference! The difference between the plodding clerk and the clear-thinking executive. The difference between the deadly bore and the interesting talker. The difference between success and failure—in business and social life.

Because he believed what he said, Dr. Eliot undertook the colossal labor of editing and arranging the 418 masterpieces which make up his greatest work, The Five-Foot Shelf of Books. Tracing the progress of civilization through more than twenty centuries, this library contains in truth the essentials of a liberal education.

And today thousands of cultured families, in whose private libraries these fifty volumes have a place of honor, are ready to testify to the value of Dr. Eliot's guidance and the truth of his words.

Is Dr. Eliot's Five-Foot Shelf of Books in your home? Now is the time to get it at last. At least send now for the interesting book called "Fifteen Minutes a Day" which describes these famous Harvard Classics. It is absolutely free to any reader of this magazine who wants it. Your name and address on the coupon will bring it by return mail prepaid. Do not delay. The time to act is now.

Give yourself and your family a *real* Christmas gift this year a lasting gift, a worth-while gift.

USE THIS COUPON NOW

P. F. COLLIER & SON COMPANY
250 Park Avenue, New York City

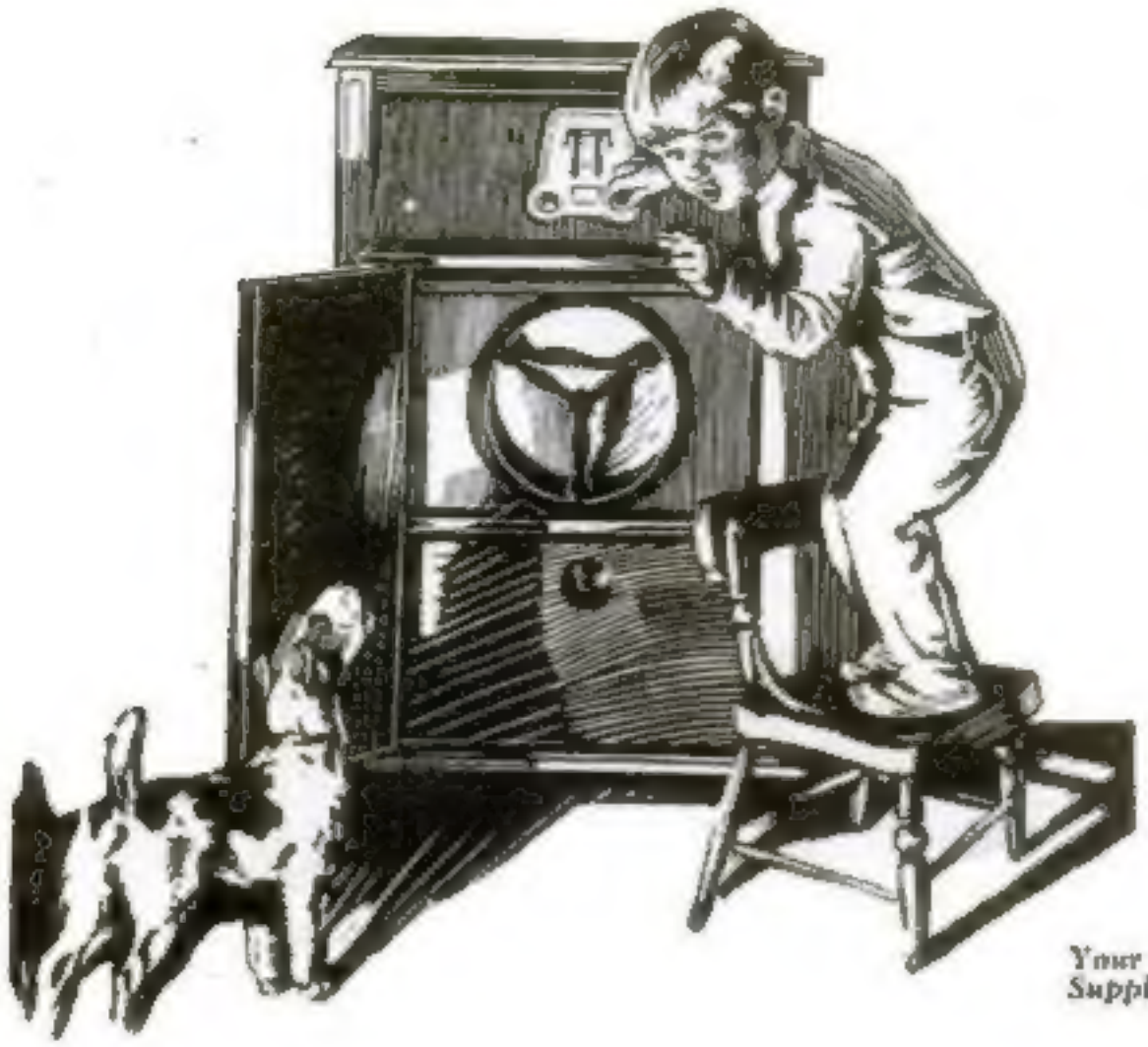
By mail, free, send me the booklet that tells all about the most famous library in the world, describing Dr. Eliot's Five-Foot Shelf of Books (The Harvard Classics), and containing the plan of reading recommended by Dr. Eliot. Also, please advise how I may secure this supreme Christmas gift and pay for it in small monthly payments.

Name { Mr. / Mrs. / Miss } .....

Address .....

The publishers cannot undertake to send the booklet free to children. PST-HCFS-L

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.



Your Light Socket Supplies All Power

THE *New* FRESHMAN

ELECTRIC RADIO

acids, trouble, batteries } **no** { water, excuses, makeshifts

Always Ready··Always Right

The cabinet panelled entirely of genuine mahogany, contains a large cone speaker mounted on a Baffle Board, which is placed in a remarkably resonant tone chamber, rendering exceptionally fine tone quality and "true-to-life" reproduction.

Freshman EQUAPHASE

COMPLETE READY TO OPERATE

$185.00

INCLUDING NEW RCA AC ELECTRIC TUBES

A Freshman development—licensed under patents; R C A—General Electric Co.,—Westinghouse Electric & Mfg. Co. and American Tel. & Tel. Co.

CHAS. FRESHMAN CO., Inc., Freshman Building, New York

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

The Traveler. The aristocrat of safety razors. In Gold Plate, $10.00. In Silver Plate, $7.50. Genuine leather case.

A *Gift* that is personal ~ a *Gift* that is practical

THE ideal Christmas gift has three qualities—it is personal, it is practical, and it is the finest thing of its kind.

Certainly the Gillette is personal—a man learns to like his Gillette razor just as he learns to like his favorite pipe or his favorite tobacco.

Surely it is practical—there's a lifetime of daily service built into every Gillette.

And there is no other razor used by so many men (70,000,000 Gillettes have been made and sold) as the razor which originated the self-shaving habit. A long-established favorite—for years the standard of comparison—Gillette razors and Gillette blades were never as fine as they are today. Your choice among a variety of Gillette models, all appropriately packaged for the Christmas season.

Gillette Safety Razor Co., Boston, U. S. A.

The New Improved

Gillette

SAFETY RAZOR

H A V E A C A M E L

Here's to Camel—on a million tables!

HERE'S to Camel. How much added pleasure it brings to the world. Wherever congenial friends gather, or in the solitary hours of work or travel, Camel insures the enviable mood of enjoyment.

All of the mysterious powers to please of the choicest Turkish and Domestic tobaccos grown are brought to fulfillment in Camel. This is done through a smooth and mellow blend that cannot be found anywhere else. For America's largest tobacco organization concentrates its abilities in Camel. Into this one brand goes all of its power to select and buy and blend for taste satisfaction. There simply are no better cigarettes made at any price.

Camel's mildness and mellowness are the favorites of particular modern smokers. So much so that Camel's popularity is greater than any other cigarette ever had. For your enjoyment of the smoothest smoke ever made, *"Have a Camel!"*

R. J. REYNOLDS TOBACCO COMPANY, WINSTON-SALEM, N. C.